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Lieutenant-Commander A. F. McCreary.
—*Frontispiece.*

Crown and Bridge-work.—*Mauk.*

The Relation of Mouth Conditions to General Health.—*Mayo.*

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Supporting Structures and Vascularization of the Teeth.—*Callahan.*

Did "Theodore Roosevelt's Teeth Kill Him?"
—*Editorial.*

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CONTENTS

Page

Lieutenant-Commander A. F. McCreary, Senior Dental Officer of Great Lakes...Frontispiece

ORIGINAL COMMUNICATIONS.

Favorable and Unfavorable Conditions in Crown and Bridge-work.
By Edwin H. Mauk, D. D. S.....487

The Relation of Mouth Conditions to General Health.
By Charles Mayo, M. D.....505

Metallographic Phenomena Observed in Amalgams.
By Arthur W. Gray, Ph. D.....513

THE RESEARCH DEPARTMENT.

A Memorial Hour to the Late Dr. John R. Callahan.
A Brief Review of His Professional Activities.
By T. Irving Way, D. D. S.....532

An Estimate of His Personality.
By Thomas P. Hinman, D. D. S.....535

A Review of the Life Work of John R. Callahan, Being Especially a Digest of His Contributions to the Progress of the Science of Correct Root-canal Technic.
By Rodrigues Ottolengui, D. D. S.....536

The Supporting Structures and Vascularization of the Teeth.
By John R. Callahan, D. D. S.....549

EDITORIAL DEPARTMENT.

Did "Theodore Roosevelt's Teeth Kill Him?".....561
The Things that Are Caesar's.....565
Why Don't They Pay Their Bills?.....566

ARMY AND NAVY.

Performing 112,440 Dental Operations at Great Lakes (Illustrated).....568
Victory Button Authorized.....572
Be Satisfied.....572
Dental Corps Orders from War Department.....572

ANNOUNCEMENTS.

National and State Societies Meetings.—The Last Chapter of the New Mexico Dental Legislation.—Maine Dental Society.—Virginia State Dental Association.—California State Dental Association.—Committee of Dental Examiners of Illinois.—South Carolina State Board of Dental Examiners.—Meeting of the Tennessee State Board of Dental Examiners.—Oklahoma State Board of Dental Examiners.—Semi-Annual Meeting of the Rhode Island Board of Registration in Dentistry.—Meeting of the Maine Board of Dental Examiners.—Tennessee State Dental Association.—The International Society of Prosthetists.—Virginia State Board of Dental Examiners.....574-576

Recent Patents of Interest to Dentists.....576

ADVERTISING DEPARTMENT.

Index.....A-67
Classified Section.....A-63-A-66

LIEUTENANT-COMMANDER A. F. McCREARY,
Senior Dental Officer of Great Lakes.

THE JOURNAL
OF THE
National Dental Association
VOL. 6 JUNE, 1919 NO. 6

Original Communications.

FAVORABLE AND UNFAVORABLE CONDITIONS IN CROWN AND BRIDGE-WORK.

By Edwin H. Mauk, D.D.S., University of California.

(Read before the National Dental Association at Its Twenty-Second Annual Session, Chicago, Ill., August 5-9, 1918.)

EVER since Hunter's diatribe against bridge-work as he saw it, the almost universal custom has been to say nothing good about this branch of dentistry, but to continue practicing it, in ever increasing volume, and in ostensibly improved forms, designated as sanitary, or wash bridges, or self-cleansing, or crowning deceit of all, removable, as if that feature offset the almost utter disregard of correct basic principles by a vast majority of those presuming to practice the art.

So much has been written and voiced in utter and sweeping condemnation of bridge-work per se, that it may seem distinctly out of style at least, if not positive heresy, to present any other phase of the subject. Yet, such a boon is bridge-work in its best form, to afflicted humanity, that any effort to recognize and augment its virtues, while acknowledging its faults should need no apology.

Let us not fail to give Hunter the credit for sounding the alarm, tho like many others before and since that time going out of their own fields to criticise, it is apparent that he was not in possession of all the facts. The geese who saved Rome, hissed and gabbled, not to save Rome, but to express their own agitation, without analysing the cause. One is struck by Hunter's failure to correctly analyse causes, as well as by the evident basing of his conclusions on comparatively few examples, and those,

we more than suspect, not of the best or even average type.

We may as well realize that Crown and Bridge Prosthesis is an institution, and is here to stay, quite as much so as the cavity filling, or the full artificial denture. We shall have bridge-work with us permanently in spite of prophylaxis ideals, and oral hygiene education. We may as well realize, also, that to free this art of the odium it has justly incurred, other favorable conditions must be present in a given case, than the ability of the victim to pay, or the favorable condition of mind supposed to be brought about by the salesman-dentist applying the ready-made formulas of some "System" of "Dental Economics."

The reason the dentist includes crown and bridge-work in his practice is too frequently not his knowledge nor skill along this line, but the fact that it is profitable. This constitutes the chief stumbling block in the way of all efforts to raise the status of the art as a whole.

Are the examples numerous of the dentist "referring" this class of work, as he does extracting or orthodontia, for instance? No, and we all know why. Its money making possibilities are too great. This has fostered the growth of one of the greatest of present day curses of dentistry, the commercial laboratory, whereby the dentist becomes all too often a mere commission merchant. It is a well known fact that many students shuffle thru dental prosthesis in college, both technical and practical, with the avowed purpose of having this work done by the laboratories after they enter office practice.

If a man is incapable of executing every detail of his bridge-work himself, or is incompetent to personally direct every step in his own laboratory, then he ought to let bridge-work alone. It is almost certain that he will not have the judgement to properly prepare an abutment, or to know when technical procedures have been properly executed to say nothing of elements of design, such as are involved in the incorporation of specific structural features.

The storm of criticism has centered mainly about fixed bridge-work, but removable bridge-work, owing to its greater complication, is even more apt to be faulty, if basic principles are ignored and favorable conditions are not secured.

Several clever "dental jewelers" have developed ingenious mechanical devices, together with systems for their use, and these are often accepted and exploited as laudable and complete methods for accomplishing all that is necessary or desirable in bridge-work.

Almost invariably men who advocate some "system" to the exclusion of others, or pick out some principle and build a technic around it, have a financial interest in the production and sale of devices necessary to the system. This may indicate good business acumen, but their professional judgement is inevitably affected by this fact.

All these efforts are not wasted. On the contrary, they all contribute to the final development of the art. The mistake lies in trying to make one system fit all conditions.

The co-ordination of methods belongs to another paper. This paper has to do with conditions. Our bridge-work always starts with conditions as we find them, not as we would have them. So, in an attempt to indicate what are favorable conditions for Crown and Bridge Prosthesis, some detailed and specific statements are made herein. These are offered with the full knowledge that positive statements always draw criticism, and fully aware that not one paper alone, nor its discussion, no matter how full, will exhaust the subject, nor finally settle some of the moot points. If this effort succeeds in grouping in a comprehensive, orderly arrangement, most of the conditions that have been recognized as favorable, stimulating further thought along this line, and elevating

the status of the art with which it deals, even to a slight extent, then its purpose will be accomplished.

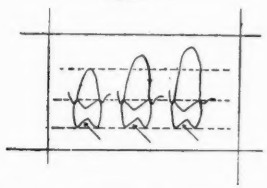
Since conditions as they present are seldom favorable, but must be modified until they are favorable, unfavorable conditions are referred to freely by way of contrast, and for clarity of illustration in concrete instances.

Basic Principles Necessary to Success of Crown and Bridge Prosthesis.

1.—*Physiologic tone* of all supporting anatomical elements and investing tissues.

2.—*Adequate support* for the bridge structure in proportion to the work demanded of it.

Figure 1.



These teeth, presenting the same amount of visible bulk projecting from the gums, would appear to be of equal value as bridge abutments.

Comparison of their roots as to length, indicates a great disparity in the amount of stress they would bear, as represented by the arrows.

3.—*Protection to soft tissues* by outline and contour form in accordance with dental anatomy.

4.—*Normal articulation* implying also normal occlusion.

Esthetics might be considered with these factors but cannot be discussed in this paper within the limits set for its length.

1.—Under the first; *Physiologic tone* of supporting structures and their investing tissues, are included: Abutment teeth and their pulps, peridental membrane, alveolus and alveolar process, periosteum, epithelial tissues, nerves and blood vessels supplying the foregoing. By physiologic tone is meant a degree of functional activity possible only to anatomical structures which are free from pathological lesions, chronic or acute.

This rules out the use of teeth as abutments having either abscesses or granulomata, or around which extensive loss of alveolus and peridental membrane has occurred or is progressing as a result of so-called pyorrhea; also the use of spongy or congested areas of the mucosa as support for saddles. The writer also ventures to record his growing belief that in the near future we will also rule out at least all multi-rooted devitalized teeth for use as abutments.

To meet the demands of this, the first and most important of all basic principles of bridge-work, admits of no halfway measures. The physical integrity and visible bulk of the teeth supporting a bridge have absolutely nothing to do with it. (See Figure 1.)

Right here the "dental jeweler" has to be curbed. If enough of a tooth is visible at each end or even one end of a space, on which to get a grip with some sort of an attachment, he builds his structure thereon and is proud of its technical excellence and its shine, regardless of the possible diseased conditions underneath. Or, perhaps he rests the structure on a saddle, and lets it float "like a pontoon bridge" as it has been expressed, over pools of pus, and boggy gums. Perhaps a few extension wings are included, to "massage the mucosa, bring increased blood supply, and rebuild the lost tissue."

Peridental membrane, alveolus, alveolar process, periosteum, and epithelial tissues, all supplied by healthy, functioning blood vessels and nerves, form the real foundation of our bridge-work —the teeth are only connecting links. No chain is stronger than its weakest link; similarly, no structure is better than its foundation.

We swell with indignation when we read of the "Huns" forcing sick, half starved prisoners to work, sometimes in

the last stages of tuberculosis. This is an apt parallel to what happens when a bridge structure is placed on roots whose investing tissues are diseased, or in any way below an average physiologic tone.

Already weakened, battling with bacterial invasion, these tissues are called upon to assume a burden of work they never were intended for, even in their normal state. This picture overdrawn? No! Today, at this very moment, "somewhere in America," bridge structures are being placed under just such conditions, in spite of the warnings that have gone forth, both from the dental and the medical profession.

If necessary to resort to forceps and curette to secure physiologic tone of the supporting tissues as one of the favorable conditions, don't temporize, even tho the removal of teeth and necrotic areas may be so extensive as to preclude the possibility of using a bridge structure.

The patient's dread of a "plate" and the dentist's dread of losing the bridgework fee, both add to the temptation to retain abutments when good judgment dictates their removal. Even so the dentist has no right to compromise with diseased conditions in the hope that the bridge will last a little while anyway, without doing the patient any harm. He cannot evade his responsibility under the plea that the patient wanted him to do it.

It seems almost an axiom to say that no bridge nowadays should ever be planned without a most thoro radiographic examination of the proposed abutments, and the areas surrounding them, not only for the diagnosis of possible diseased conditions, but also for the prognosis based on the size and form of roots as revealed by the x-ray. (Figure 1.)

2. *Adequate support* for the bridge structure in proportion to the work demanded of it.

(Rules out long bridges on two abutments, fourteen unit bridges on four total abutments and piers, when opposed by natural teeth, extension bridges with one or more pontics except in rare instances, loose end or "Swung in" bridges of one or more pontics and without a lug or spur on the free end.)

What would we say of the engineer who built his long span bridge on two abutments, knowing from his load and factor of safety tables that four abutments were needed? Irrelevant, you say, because the engineer is not limited to abutments already there, but can build as many as he wants, where he wants them. Not always,—and when he encounters that condition, he doesn't build a bridge, he uses a ferry. Here, again, looms the dread shadow of that "plate."

Whenever this subject comes up, someone is sure to refer to one of *his* fourteen unit bridges that has "been in for twenty years." When we get the full details, it usually appears that there are several abutments, therefore a series of small bridges in reality, or that the individual roots are of unusual length and firmly set in their sockets, with dense investing tissues, or that the bridge is opposed by artificial teeth. This merely proves the exception to the general rule.

It would be impossible to lay down an infallible rule as to how many pontics* may be allowed for each abutment. Too many factors enter into the calculation to make this practical. As a working basis, we may say that a limit of one pontic for each abutment cannot be exceeded without danger of premature loosening and loss of abutments. This applies especially to pontics intended to serve the purpose of mastication and may often be safely modified. Laterals can seldom if ever be relied upon to successfully support even this proportion of extra load. You will observe that this exactly doubles the work required of any tooth and its attachments when used as an abutment. It may be

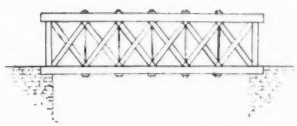
*Suspended member of a dental bridge. Committee on nomenclature, Amer. Inst. of Dental Teachers.

argued that the stress can be distributed in greater proportion upon the multi-rooted abutments, and diverted from the single rooted. This may be true in a single position, say that of central occlusion, but cannot be maintained in a lateral excursion of the mandible.

Short crowns and long roots modify this proportion also, as the leverage exerted in mastication is thereby much reduced, while the resistance of the abutment is increased in much greater ratio. (Figure 1) Here again the radiograph is of incalculable aid in determining what is adequate support.

Straight bridge vs. curved bridge. Another factor is expressed here. A bridge supported from cuspid to cuspid is subjected to a stress totally different from the stress received by a bridge of equal length from the cuspid distally. With supports of equal value, the curved bridge will fail soonest, because of the cantilever action set up. All extension, and "swung in" or loose end bridges with support at one end only, are subject to this limitation imposed by cantilever action, and their value, therefore, is extremely doubtful, even when built in part upon saddles, either fixed or removable. (Figures 2, 3, 4, 5.)

Figure 2.



A somewhat complicated form of bridge structure, but which imposes practically none but vertical stress on its abutments.

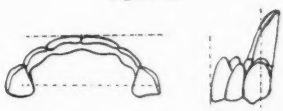
This is the prototype of most dental bridges, whose rigidity is attained by mass rather than by truss construction, as above.

Practically all dental bridges must sustain stress in two planes. That in the horizontal plane often exceeding the vertical stress, (anterior bridges) which is not the case with mechanical bridge structures. Hence the necessity for greater proportionate abutment resistance in dental bridges.

Saddles. Reliance upon small saddles, for supporting the stress of mastication, particularly lateral stress, and for taking this stress from the abutments, is a delusion. When saddles are made to cover sufficient surface to take this stress successfully, the structure becomes in reality a partial plate, a subject outside the scope of this paper.

Small saddles; (by "small" is meant those which cover up to approximately double the area of the occlusal surfaces of the teeth they carry) rapidly "settle" as absorption takes place under them in response to the stimulus set up by use in mastication. When a point is reached where the teeth on the saddle are relieved of the major part of the force of occlusion, the bridge is no longer efficient in mastication. If mechanical stops are provided on the abutments which check the settling process before the limit of absorption is reached, then the saddle no longer affords a means of support, the load being transferred to the abutments. These small saddles, then, must be utilized not to support masticating stress, but as bases upon which to terminate and finish the contour forms in contact with the mucosa, and to block out partly triturated food which would otherwise be impacted between pontics, abutments and soft tissues. This use must be confined to removable bridges, and is contraindicated in all fixed bridges.

Figure 3.



A dental bridge wrong in principle, but which may last for years, if on abutments with exceptionally strong peridental attachments, provided that the posterior natural teeth are present in such alignment as to take practically all the stress of mastication, or if opposed by artificial teeth.

This same bridge becomes a menace to its abutments as wear of the posterior teeth progresses, or if several of them are lost.

Remedy; more anchorage, or substitute a plate.

The only condition which can be considered favorable for the use of an ex-

tension bridge may be said to exist when the extension exposed to leverage forms a relatively short arm compared with the total length of the bridge, and when the abutment from which the extension is made has unusually firm support in its alveolus. For instance, an extension consisting of a molar pontic may be made at the distal end of a four unit bridge from cuspid to first molar, *provided,* the molar abutment has well developed diverging roots, and the "bite" is short. (Figure 5B.)

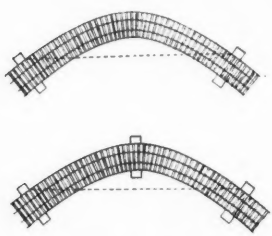
This would meet with the requirements of adequate support, altho there are other objections to this device. Another instance where an extension is permissible is that of a lateral incisor at the anterior end of a bridge similar to the one just mentioned. (Figure 5A.)

Loose end bridges, with supports at one end only, all subject their abutments to a twisting stress, in addition to the vertical and lateral, which cannot be considered other than as extremely unfavorable. (Figure 5C and D.) Lugs or spurs, resting in depressions or fillings in adjoining teeth, are often sufficient to change this to a favorable condition, permitting the use of more than one pontic. (Figure 5E and F.)

All the above considerations as to adequate support, are modified by the presence of opposing artificial teeth. Distinctly unfavorable conditions, involved in an excessive number of pontics per abutment when opposed by natural teeth, would become favorable conditions immediately if the same bridge were to be opposed by artificial teeth on a plate.

Favorable conditions can never be secured for the type of extension bridge sometimes used to supply molars and a bicuspid on one side only, depending for its support solely upon one or two teeth at its anterior end, and with a saddle.

Figure 4.

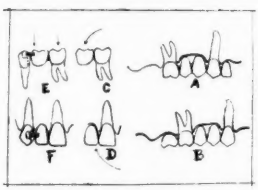


Upper figure. A mechanical bridge structure closely analogous to the dental bridge from one cuspid to the other, with no other support. Structurally unsafe.

Lower figure. The same structure made safe by the addition of a center pier.

Since the forces of mastication and incision set up in the human mouth impose extremely complex stresses which no mechanical bridge structure ever has to bear, no exact prototypes of dental bridges can be shown. These illustrations of bridges serve merely to indicate some of the principles involved.

Figure 5.



A—An "extension bridge" often permissible. Can be said to constitute a favorable condition.

B—Another extension bridge sometimes permissible. Cantilever and twisting stresses both greater in this case than in the bridge shown at A. Not so favorable a condition as shown at A.

C and D—Extension bridges presenting extremely unfavorable conditions. The stresses set up greatly endanger the peridental attachments of the abutments.

E and F—The addition of lugs or spurs resting in grooves in fillings placed in the adjoining teeth takes some of the stresses off the main abutments, and produces favorable conditions.

Outline and Contour Form.

This does not imply a slavish reproduction of every pit, line, angle, fossa or groove on the surfaces of the natural teeth, since some of these, as for instance, fissures and pits between lobes of calcification, are structural faults. It does imply a strict observance of the features which protect interproximal tissues and the gingiva, such as: contact points,

Figure 6.

Figure 7.

Figure 8.

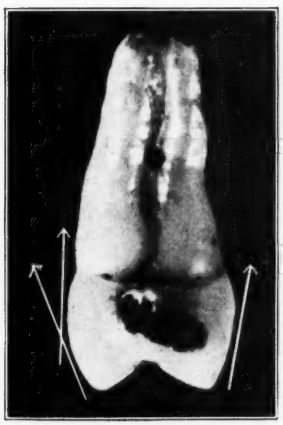


Figure 9.

A series of upper teeth, the four typal forms, incisor, cuspid, bicuspid, and molar.

Attention is called to the slope of the labial, buccal and lingual surfaces as the gingival border is approached, and the effect this slope has in protecting the soft tissues by diverting food over the free gum margin.

This feature is present in varying degree in all the teeth, these four typal forms being representative of all the others.

bulges and tapers of enamel surfaces, especially at the gingiva, inclines of enamel surfaces which divert masses of fibrous food harmlessly over the gum margins, (Figures 6 to 11 inclusive,) and, lastly, all surfaces so designed as to retain food debris to the least possible extent.

Dr. G. V. Black has shown how essential to the success of filling operations is the observance of the very smallest details of dental anatomy. A filling operation is a restoration of but a *part* of a tooth crown. How infinitely more important it is to observe every feature of dental anatomy when restoring the *entire* crown of a tooth. The injury inflicted by bridge-work upon the soft tissues of the mouth and the pathological conditions resulting therefrom, culminating but not always terminating in the loss of the structure and its abutments, constitute one of the chief counts in the almost universal indictment of bridge-work in general. This can almost invariably be traced back to an utter disregard of the protection afforded the soft tissues by the outline and contour forms of the best examples of natural teeth. (Figures 6 to 11 inclusive.)

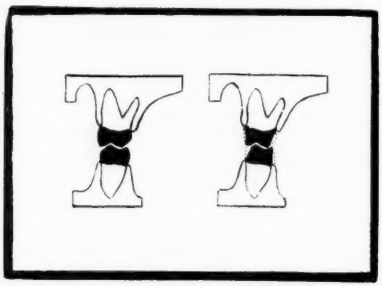
Figure 10.

Lingual aspect of a molar tooth. Greatest diameter thru contact points, narrowing apically affords room for interproximal tissues and protection to same.

This feature more often neglected in artificial crown restorations than the contours of labial and buccal and lingual surfaces.

Bridge and crown units whose sides present perfectly straight lines occluso-gingivally may form a milling mechanism for the reduction of food, fully as efficient as if these outlines were formed of curves. (Figure 11.) *But we know*, from the study of evolution, that the curves and prominences on the sides of teeth have a purpose. They are not there as the result of accident. Nature does not develop the complex curve where the simple straight line will do. What that purpose is, and the causes underlying it, our business is to find out, and having found out, to apply the knowledge, not tag it and throw it into a heap as so much mental junk.

Figure 11.



Diagrams of crown restorations, with occlusal surfaces of the same form, one set of crowns having normal contours on their buccal and lingual surfaces, the other presenting straight lines on these surfaces.

In both cases the masticating efficiency is equal, but no protection to soft tissues is afforded by the crowns with straight sides.

It is not sufficient to make a crown merely touch its neighbor in the arch, even if the neighbor is an artificial crown, and there is no danger of decay on these two surfaces. The contact must be of a definite form placed within a definite

area, bucco-lingually, and gingivo-occlusally, if it is to fulfill the function of protecting interproximal gum tissue from fibrous food forced down upon it. The fibers must be bent, broken and diverted over the gum septum. (Figure 10.)

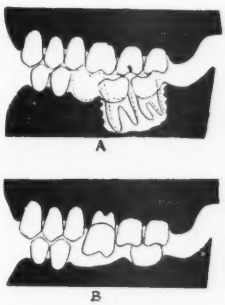
It is much easier to carve a crown of almost circular outline than to make line angles or to conform to any of the geometric cross-sectional forms of the teeth, yet every one of those variations in form has its reason and purpose. *It is not sufficient* to bevel the edge of a band, and to make it follow the curvature of the gingiva. *It is not sufficient* to make the termination of any crown, at its junction with the stump, continuous and flush with the tooth surface extending apically. The bevel, the thickness, the bulk of the original, or the ideal tooth, at that point, must be produced, to protect the gingival tissues. *It is not sufficient* to produce curved surfaces on a crown from occlusal to gingival. Every element of the curve of a buccal or lingual surface, has a relation to soft tissues, and the inclination of that surface as a whole to the line of the force of occlusion also affects the investing tissues. (Figure 12.)

Figure 12.

A reconstruction of molar teeth in situ. Arrows show direction of masses of food in mastication being diverted over the thin edges of the gingival gum tissues.

Nor is this all! For various reasons, especially in a fixed bridge, it is not practical to make pontics the full size and contour at their bases of the teeth they replace. No matter how they are designed, there are areas not reached by tongue, lips or masses of food in active motion. These areas, then, must receive especial care to make them accessible to cleansing operations by the patient and to reduce to the minimum their tendency to retain debris. Convex surfaces, and sufficient space between necks of artificial teeth and mucosa to admit cleaning appliances are favorable conditions which it is essential to secure in this particular.

Figure 13.



A—Teeth so tipped as to greatly impair their masticating function. Loss of interproximal contact, and resulting food impaction leading to pyorrhea, thus adding another unfavorable condition.

B—A tooth so extruded as to preclude normal articulation and occlusion of the bridge made to oppose it, unless it is first reduced to the length of the adjoining teeth.

Normal Articulation—Implying also, Normal Occlusion. Not compatible with:

1.—Use of teeth so tipped in any direction as to lose function of one half or more of the occlusal surface, without restoring the lost function. (Figure 13 A.)

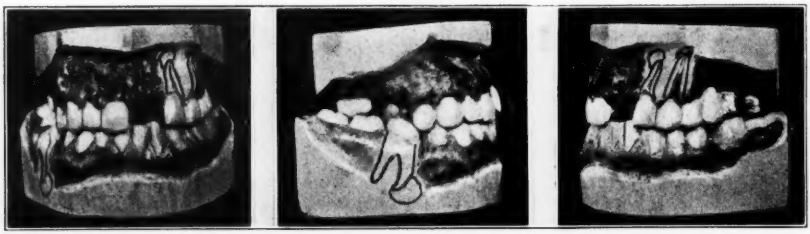
2.—Placing bridges in opposition to teeth extruded markedly beyond the

occlusal surfaces of the adjoining teeth. (Figure 13 B.)

3.—The use of occlusal surfaces which are merely the reverse of the opposing teeth and not true tooth forms.

Having secured all the preceding favorable conditions, we come to the last, and probably the least understood of all the problems involved; the very thing without which the structure is valueless, except for esthetic effect; namely, the normal functional relations of the occlusal surfaces of our crowns and bridges to their opponents.

Figure 14.



Casts from a patient presenting for bridge-work, showing an unusual number of unfavorable conditions.

A bridge had been constructed on the left side, restoring the upper lateral, cuspid, two bicuspids, and two molars with the cuspid and second molar as abutments, and a gold "dummy" for the first molar, no connection being made to the broken-off lateral root left under the bridge.

The dentist seized the opportunity afforded by subsequent loss of the central to make a gold plate to carry this tooth. Practically no attempt has been made to restore occlusal surfaces on any of the bridge teeth, the molars were almost flat, and the bands of the cuspid and molar abutment had caused extensive hypertrophy and inflammation of the gingiva.

Abscesses disclosed by the radiographs are sketched on the casts at the roots of three teeth. Both lower second molars are tipped forward, with bad spaces anterior to them, and extruded considerably above the plane of occlusion. The right upper second molar occludes with its buccal cusps inside the buccal cusps of the lowers. The "bite" is so short on both sides of the upper that no form of fixed bridge can be made that will be even moderately clean.

An unfortunate feature in connection with this case was that the patient, a man in public life, and of more than average intelligence in his calling, could not be made to see the necessity of anything more than patching up the bridge to supply the missing central incisor.

Many a bridge which has brought its share of condemnation on the art of Bridge Prosthesis, and caused the premature loss of its abutments, would still be rendering efficient service if even a moderate approach to anatomical articulation and occlusion had been secured. How long would a set of closely adjusted transmission gears last in which one tooth was appreciably longer than the others? Just one revolution—either the tooth, the bearings or the supporting framework would be broken.

This condition is analogous to that in a bridge having one cusp which occludes without undue pressure, but which forms the only point in contact during a lateral excursion of the mandible, the supporting structures not being rigid, yield under this impact repeated hundreds of times at each meal, the abutments and the opposing tooth become loosened, with attendant inflammation. Wear of the high point takes place in time and the symptoms subside. But let us visualize a bridge with a series of inclined planes, which tho occluding without inconvenience, receive all the force of the masticating muscles in articulation. The aggregate of the surfaces involved is too great to wear down readily, and the displacement of abutments goes on daily in a staggering total of impacts. No tissues, no matter how elastic, can resist this action, and a permanent loosening of peridental attach-

ments takes place in permanently enlarged sockets. All the attendant train of evils follows.

No amount of sophistry involving the relative merits of fixed or removable bridges, can cloud the issue of faulty articulation once it is understood. Many of the evil results of both types of bridge-work will be prevented by an application of even the rudimentary principles of anatomical articulation. To secure this it is not sufficient to merely test our wax patterns, and cast or swaged cusp forms in the mouth, carving or grinding the high points as indicated. When we are doubling or trebling the strain on abutments by making them support bridges, what can be of greater importance than the production of the most highly efficient cutting and triturating edges and surfaces upon the bridges themselves?

Two flat surfaces in opposition can be made to crush food if actuated by sufficient power, and backed up by sufficient resistance. Available supports for bridge-work do not afford this resistance, tho the power of the muscles of mastication be ample.

Recall the appearance of some of the crowns and bridges you have seen. Slightly rounded eminences, in imitation of cusps, and shallow marks or grooves between, describes the occlusal surfaces of a large majority of them. Another conception seems to be embodied in a reverse imprint of the opposing teeth. This may produce perfect fitting of one opposing surface into another but is not in comformity with any principle of articulation.

Occlusion and articulation can only be secured by a deliberate design of cusp fitting into groove, with its own individual path for lateral excursions. Efficiency can only be secured by the incorporation, even the exaggeration of every ridge, cusp, sulcus or groove that has to do with the trituration of food masses. The very materials we have to work with, impose their limitations. Gold and its alloys are too soft to retain sharp edges, porcelain does not lend itself to carving and must be ground down from its original form or carved and baked for the individual case, where manufactured forms will not fit in accurately.

In conclusion, let me make a strong plea for conservatism in summing up the indications favorable for a bridge in a given case. Don't inflict upon a patient a bridge you would be unwilling to tolerate in your own mouth under similar conditions.

The fundamentals mentioned may not be all that is essential in determining where and how a bridge shall be placed, but it is certain that disregard of any of them will make its effect known in a material shortening of the term of service your bridge structure will render.

Discussion.

J. F. Hovestad, D.M.D.—Boston, Mass.

Prof. Mauk has just told us that the title of his paper should have been "Favorable and Unfavorable Conditions for Crown and Bridge-work." I therefore deem it necessary to explain to you, what I mean in my discussion, when I am referring to the importance of considering the *mental condition* of our patients in diagnosing their cases and in executing the work.

Dr. Mauk in his paper speaks only of "physical" favorable or unfavorable conditions. However, it has been my experience that we very often may have a *"favorable"* physical condition for Crown and Bridge-work but the patient's mental condition for such is *"unfavorable,"* and vice-versa.

We shall never succeed in obtaining a satisfactory result, until we establish a mental mutual understanding and thereby obtain the co-operation of our patients.

I am indeed very grateful to your

committee which selected *Prof. Mauk* to read this fine paper, also for the courtesy shown *me* to discuss Prof. Mauk's paper. It has been my privilege to discuss in the past twenty-five years many papers on crown and bridge-work, but I must truthfully say, that none of these papers of the past can compare with the soundness and common sense of the one which we all have just listened to.

STANDARDIZATION.

Dr. Mauk has treated this broad subject strictly on the basis of his knowledge which he has gained by observation in years of practical experience. His paper is very much in line with papers such as were read before this society by Prof. Orton and Prof. Knoche within the past two years,—on standardization of crown and bridge-work.

MORE LIGHT NEEDED.

We all realize the great need of more light on this subject. What a contrast and also what a great help such a paper as this is to us compared with papers dealing with only some type, system or method of movable, removable or jewelry bridge-work,—work that is comparatively new and untried and often so complicated that most dentists from the very start feel that to do such work, is beyond them. Besides as Dr. Mauk rightly states, it is based in most cases on a financial interest in the production and sale of devices necessary to the system. I am glad to hear Dr. Mauk say that.

OBJECTION SYSTEMS.

I do not want you to think, that I do not appreciate the good, that some of these efforts have contributed, to the development of crown and bridge-work, but I do object to the erroneous statements, teachings and advertisements of the promoters of these systems, to make the dental profession in general, believe that their *one* system fits *all* conditions. Such statements have on the *inexperienced* men a rather confusing and *discouraging effect.* I say *inexperienced* men, for men like Dr. Mauk and others *who know,* cannot be confused so easily by such statements.

BRIDGE-WORK HAS COME TO STAY.

I perfectly agree with Dr. Mauk that crown and bridge-work *in its best form* is a boon to afflicted humanity and that *it has come to stay.* Just because Dr. Hunter and a few other physicians and dentists have condemned bridge-work in general, such as *they* saw, does not necessarily mean, that we all must or should give up doing *good* bridge-work, or that we should turn from the *fixed* type to the *removable* type of bridge-work.

CAUSE AND EFFECT.

We must not overlook the fact that the criticisms of these men are based on the result or *effect,* produced by poorly planned and poorly constructed bridge-work. The *causes* of these failures are rarely understood or often ignored by these men that do most of the talking against the work. To *correct* these failures we must *look for* the *error* in our work and correct it. Now, Dr. Mauk in his paper has pointed a way for us *to detect* and *to correct* some of these errors. He says, that the following four *basic* principles *are necessary* to follow:

1st—Physiologic tone of all supporting structures and their investing tissues.

2nd—Adequate support for the bridge structure in proportion to the work demanded of it.

3rd—Outline and *contour form,* in accordance with dental anatomy.

4th—Normal articulation, implying also normal occlusion.

I feel quite sure, that if we follow these four rules that this will eliminate to a great extent some of our failures of the past and bridge-work will then be appreciated as *the best means* to the

normal or natural replacement of the lost teeth.

THE DENTISTS' MODEL.

I do want to picture to you what I understand of reproducing *normal forms,* articulation and occlusion of Dr. Mauk's rule No. 3 and 4.

The artist that paints a picture or molds his subject in clay, with him, it is the selection of the right models and their reproduction in paint or clay upon which *his* success depends. The artist does not always want the perfect form of man or woman as a model. He wants a model to suit his subject and this is exactly what *we want,* when we try to reproduce a lost condition of the mouth. We must give up the erroneous idea that we must or can reproduce in all cases a *perfect* or *normal* condition. This we cannot do, we can only hope to bring about a natural condition or nearly such.

Please do not misunderstand me when I say that we cannot hope to restore the perfect or the normal. This will probably be best understood or appreciated by the orthodontists. Many patients of advanced age, come to us for the replacement of lost teeth. We are *always* dealing with an *abnormal condition* of the teeth and mouth and our success for the restoration of these lost members depends greatly, first—on the patient's mentality and on what there is left in the mouth to build upon. Secondly on *our skill* and the manner in which *we plan* and execute the work. It is for us *to know* if the condition for a bridge are favorable or unfavorable. I agree with Dr. Mauk, that if a case looks too difficult for the general practitioner, it is best for the patient as well as for the dentist, to send this patient to a crown and bridge specialist, as we do with our orthodontia patients.

And now we come to, how to determine favorable or unfavorable conditions. Dr. Mauk has said much in a general way about this, but he did not mention the need for us to determine the *mental condition* of our patients and also omitted the value of study models such as the orthodontists use. *To plan* our work, we should always remember that each and every case is a study in itself. That is true not alone of the conditions of the teeth and mouth but also of the mental and physical make-up of the patient. We have to do more than just to look, *how to fill the space,* and to examine the teeth which we intend to use for anchorage. To plan the work rightly requires time and thought. Radiographs of all *doubtful* teeth and areas, and also of those teeth which we want to use for abutments should be taken. Study models such as the orthodontists use, of *all the teeth* in the mouth are necessary, even if we intend to restore or to fill in one space only. These radiographs and models of the entire mouth, give us a fair idea of the general condition, and this will be a help to us to form and to outline a *mental picture* or *model,* from which to reproduce and to bring about a *natural* and harmonious restoration.

NATURAL RESTORATION.

To illustrate my point regarding *natural* restoration. If the opposing natural teeth which are to articulate with the crowns or bridge teeth are malformed, worn down, have flat cusps, are spaced or tipped, we surely would or should not try to imitate, and reproduce for the artificial restoration, the normal or perfect shape or form of teeth such as we find in younger and more perfect mouths. We must reproduce in size, shape and occlusion the foundation, the crowns and supplies to fit the opposing teeth and the *general condition of the mouth,* always in accordance with dental anatomy.

ELIMINATION OF PATHOLOGICAL CONDITIONS.

Our attention was called to the need of eliminating pathological conditions of the teeth and mouth such as we may find present. I feel quite sure that the

majority of our failures, in crown and bridge-work in the past has been due to our ignorance, neglect or *limited knowledge* to properly deal with these conditions. We surely cannot afford to go ahead with our work, until we have brought about to the very best of our knowledge a *sound foundation* of roots and teeth upon which we intend to build.

Disagree With Dr. Mauk.

I have now come to that part or point of his (Dr. Mauk's) paper, where I cannot agree with Dr. Mauk's belief where he says: the writer also ventures to record his growing belief, that in the near future we will also rule out at "least" *all multi-rooted devitalized teeth as abutments.* This, his statement, recalls to my memory a statement that was made by Dr. Goslee some ten or twelve years ago regarding devitalization of teeth. Dr. Goslee at that time read a paper in Boston on crown and bridge-work. Two crown and bridge teachers from the two Boston dental schools were invited and present to discuss the paper. At that period, the use and the abuse of gold crowns were in vogue and like today, many failures resulted from the poor tooth preparations of the teeth to which the crowns were fitted. Rather than to devitalize many gold crowns were then fitted, even to the anterior teeth. Dr. Goslee in his paper justly condemned such dental work and *as a remedy he* recommended the devitalization *of all teeth* that were to be crowned. As for the anterior teeth, this would enable the dentist to fit porcelain crowns and for the molars it would enable them to get a better tooth preparation. Many dentists at that time could not get with their limited skill and lack of proper instruments, good tooth preparations, especially for vital teeth. Dr. Goslee was most sincere and meant well, when he voiced a great need for *better* and more *ethical* dental work, and at that time he himself believed in his theory for devitalization. His paper was well taken, that is there was only one man in the audience that rejected his theory and the practice of the destruction of dental pulps "en masse." I had to do it and I pointed out at that time, that ways and means would be found in the near future to deal with these problems, that is to say, to enable us to get a perfect root preparation for vital teeth and also use porcelain crowns without devitalization.

My discussion was based on facts, for I as well as many other dentists in the past and *at that time* had done and were doing crowning of vital teeth which showed good results, for the ethical effect the so-called Carmichael crown was used for bridge-work and for single crowns, some of us were then using the all-porcelain jacket crown without destroying the pulps of the teeth.

Difference of Opinion.

To give you an idea of the unsafe or uncertain feeling among dentists regarding the crown and pulp question at that time, there was not another crown and bridge man or general practitioner at that meeting, that could or would oppose Dr. Goslee's views on this subject. The only support I had at that meeting was from Dr. Eugene Smith, who was then the head of the orthodontia department at the Harvard Dental School.

You will all admit that to devitalize all teeth to be crowned, such a theory would find very little support with us today. But now the pendulum swings the other way it seems and I stand before you and openly oppose Dr. Mauk's view regarding the rejection of all pulpless teeth from crown and bridge-work. I venture to say that in the near future the medical and dental profession as well as the public in general, will be convinced, that *good* root-canal work *is possible* and *is safe.* Some of this *good* root-canal work is *being done today* by many careful and conscientious operators. It is done here in your very midst.

No operator may be considered careful or conscientious to do root-canal work and *to do* it well, unless he has *acquired the skill, by giving this root-canal work* his utmost attention. A crown and bridge specialist in particular should deem it his duty to become *an expert* in this line of work. I feel quite sure and I know from experience that such a careful and conscientious root-canal expert, will never try to save and to treat and treat for weeks and months hopeless root conditions as this is being done daily by some men. *He knows* from experience what is a favorable condition and what result he may reasonably expect and it is *he who knows* the *unfavorable condition when he sees it* and *he* loses no time over it, to resort "to the forceps" and curette in such cases. I appreciate the work that has been done to solve this problem by men like Dr. Callahan, Dr. Rhein, Dr. P. Howe and others. Also the Dental Research Society.

FIXED VS. REMOVABLE BRIDGE-WORK.

Referring to removable bridge-work, it seems as tho this work has been looked upon *by the layman* as the solution and elimination of all the faults and defects that bad fixed bridge-work is blamed for. He is mistaken. I dare say, that the man that has made *bad* fixed bridge-work in the past, will also make bad removable bridge-work. Yes, even worse and with the same bad end results, such as Dr. Hunter saw.

THE NEED OF TODAY.

What is most needed today, far more than the knowledge of the principles of movable, removable part or parts of bridge-work, is a standard of root and tooth preparations and the skill to fit a crown or bridge base to such a prepared root or tooth *to meet the requirements* as Dr. Mauk so admirably has outlined to us in his paper. If this is accomplished, then I feel sure, that the rest of the bridge-work, be it fixed or removable, will follow and will be built on similar scientific lines and the work complete, will stand the test. (I wish that our society could give us some papers on scientific root and tooth preparations in the near future.) I am pleased to hear Dr. Mauk call a spade a spade. Gold clasp dentures do not belong under the C. & B. classification, and again when he refers to the bridge saddles. These bridge saddles which are supposed to support the fixed or removable bridges and to take away the stress from the bridge abutments, are indeed *a delusion.* They have been a great disappointment to me, I can assure you.

In closing my discussion, I cannot help but to sound a word of warning in precaution against some of the wild claims that are now being made against bridge work and most particularly against pulpless teeth.

Ladies and gentlemen, there was never a time in the world's history where there was such a great need of enlightenment and understanding on this subject, as there is today. It is indeed a serious question, and it needs the utmost attention and study *of us all* to know what is best *for us* to do, to protect our patients' health and at the same time save their teeth. I do not doubt the sincerity of some of the physicians and oral surgeons, but I have disproven so many of these theories, that I begin to doubt and I feel that is is *up to we dentists* to take our stand. Permit me to say that this question has given me as much to think of as it has many of you. We cannot fail to realize that the health or possibly the very life of our patient depends upon *our good judgment, decision,* and *work.*

But how can we decide when in doubt?

I know of no better way to decide *when in doubt,* what is *best for our patients,* than to place ourselves in their position and do for them, or have it done by other men, just as we want it done, for ourselves.

Victor C. Smedley, Denver, Colo.

Dr. Mauk has given us a most excellent paper and a very timely one, too, right now when the pendulum of the great clock of time is swinging back with a wide sweep across the land, from ocean to ocean, threatening our beloved profession with a reversal to the practice of fifty to one hundred years ago, when extracting and the making of plates was all that the dentist felt called upon to do.

The doctor refers to Dr. Hunter's memorable paper which first called forcible attention to the status and character of our American bridge-work. Dr. Mauk evidently feels as I felt at the time, and still do feel, justly and thoroly indignant that he should include all American bridge-work in his scathing criticism and condemnation. I agreed with Dr. Mauk most heartily, that the vast amount of rough and ready, commercial laboratory, make-'em-big enough to slip over everything and cement on stuff, is a disgrace to humanity and a menace to health. At the same time, I thought as I have no doubt that most of you thought also: "Dr. Hunter has never seen any of my bridges or he would never have made such a sweeping statement." Since then I have taken off a lot of my bridges and I expect to take off a lot more.

With the conditions revealed by the X-ray, and with the problem of reproducing normal tooth form; and of the exact function of contour, of embrasures and of normal contact relations; and with the medical profession and the public-at-large looking up to us as vital factors in relation to the great problems of human health and in fact of human life itself, we must either revolutionize our method of making bridges or quit making them altogether.

As Dr. Mauk says, crowns and bridges are too important and of too much value to humanity to be thrown into the discard. But, gentlemen, it is some task for us to acquire the knowledge, the skill and the technic to reproduce faithfully and accurately in our crown and bridge-work the exact tooth form, both occlusal and peripheral, normal to each individual mouth. J. Leon Williams, a man with a vision and an ideal, and a trained and skillful artist, spent the best years of his life studying and striving to reproduce natural tooth forms. We are all familiar with how well he succeeded in providing us with improved porcelain tooth moulds. But this comes far from giving us exact reproduction of the normal tooth form in each individual mouth and especially as applied to crown and bridge-work. This knowledge and skill must be possessed by each individual dentist attempting to do this work as it should be done.

Dr. Orton has a beautiful vision of a national standardization of crown and bridge-work. I sincerely hope this may be realized, but my personal belief is that there can be no standardization of crown and bridge-work until there has been evolved a system and a technic that is accurate in reproduction of Nature's intention in each individual mouth, and at the same time, sufficiently simple to be easily acquired by the average practitioner of dentistry.

Dr. Mauk speaks rather scathingly of "complicated systems and ingenious mechanical devices developed by clever dental jewelers." Perhaps the king among these is the "Chayes System of Movable Removable Bridge-work." This system undoubtedly has real merit but as Dr. Mauk says, is too much imbued with the spirit of commercialism and certainly inclined to include teeth that should be extracted, taking too long chances on the beneficial effects of the massage action of the extension wings and of the "Movement of the Teeth in Function." But anyone who has seen this work in the mouths of patients as carried out by Dr. Chayes himself, will have to acknowledge that the results are beautiful and that it seems to measure up to all that

he claims for it. However, another objection to it is that it is too limited in its scope.

The time required to make one of these fixtures is perhaps ten times that of another careful technic, and the fee of from $100.00 to $1,000.00 per tooth, is prohibitive to perhaps about 98 per cent of the people. Giving us a system of bridge-work applicable to about one-tenth of one per cent of the people whom we are morally obligated to serve. We should not forget that we are public servants. We have consecrated our lives to one of the branches of the great healing art. And we have been educated largely in public institutions, at public expense. To administer to the health and welfare of the public, at fees that are reasonable and just to our subjects as well as to ourselves and for our families. We must then of necessity evolve and adopt systems and methods of practice that are applicable to the needs and possibilities of the masses.

Speaking of the style and contour of bridge dummies, Dr. Tinker, of Minneapolis, shows the keenest, the most appealing thing evolved to date. He makes his dummy the normal contour of the tooth replaced from the gum line to and including the occlusal surface. That portion in contact with the gum tissue is blunt and rounded and consists of a highly fused porcelain surface indented slightly into the gum tissue. This is non-irritating and if properly constructed, more cleansable and healthful than any type of shelving or so-called prophylactic construction.

If the time permits we will touch briefly upon the subject of bridge abutments. A very *vital* subject just at this time when the devitalization of teeth is rapidly coming to be looked upon as next thing to a criminal offense.

It is practically never necessary to devitalize a tooth for the purpose of using it for a bridge abutment. Neither is a parallelodrill, or any other complicated appliance or technic, necessary for the cavity preparation for gold inlay bridge abutments that will permit the seating of the finished piece with finger pressure, and that will support any bridge that should be inserted in the human mouth, until the cows come home.

Prepare merely a G. V. Black class 2 cavity preparation, slightly modified to meet this special requirement. Increase somewhat the tapering of all walls, using the Joe Dandy separating disc and the tapered cross-cut fissure bur; finishing the preparation with the similar shaped small Miller stone.

At the mesial or distal, occlusal fossa, as the case may be, drive a generous pit for anchorage. This pit need not encroach any more closely upon the pulp than any other part of the cavity. It is also an advantage in retention to make the central portion of the occlusal step a little more shallow and toward the buccal and lingual portions provide a groove extending just a trifle deeper than in the average normal Black cavity. Provide, also, that the axial portion shall be more shallow than normal, except buccally and lingually, where grooves are indented for additional retention. With reasonable care in watching the position of the hand holding the hand pieces, this gives a cavity or a series of cavities, with all walls sufficiently near parallel to permit the easy seating of the finished fixture without any difficulty whatever. We have not encroached upon the pulp any more closely than is the case with a normal class 2 Black cavity. We have denuded less sensitive dentin of its protecting enamel, thus subjecting the pulp to less shock than would be the case with a correct preparation either for a full shell or a three-quarter crown. We have provided with our four-wall enclosed step-and-pit form, the most effective anchorage with the least destruction of tooth structure possible. We have also here the obvious

advantage in fit provided by the making of an inlay rather than an overlay. This advantage is due to the normal shrinkage of the gold in cooling, which is slight to be sure, but sufficient to be an advantage in the seating of an inlay and a disadvantage in the seating of an overlay. This inlay should be cast with pure gold reinforced with small gauged tungsten or molybdenum gold coated wire, bent to conform to the occlusal grooves and pit anchorage, the free ends being permitted to project to engage first the investment of the wax model, and second, the solder attaching the dummy. This tungsten and molybdenum gold coated wire is provided to the profession at cost by the Dental Research Commission at Cleveland. The tensile strength of tungsten is thirty times the tensile strength of pure gold, while the tensile strength of molybdenum is fifteen times that of pure gold. The molybdenum is less apt to splinter or fracture on cutting and bending and is no doubt sufficiently strong for this purpose. Another, and by no means the least advantage of this type of bridge abutment, is the fact that we have allowed to remain unmutilated Nature's unsurpassed,—yea, her unequaled workmanship in producing the correct peripheral contour of this tooth.

The man has not yet happened who can repair the damages done after he has ruthlessly and unnecessarily denuded any portion of Nature's masterpiece in art, a human tooth, of its graceful, beautiful and essential normal contour, so well described by Dr. Mauk.

Do not misunderstand me: if it is necessary to destroy or alter Nature's handiwork in order to make a satisfactory replacement, or to restore to efficiency a crippled masticatory apparatus, we should not hesitate to proceed, even to the extent of throwing completely into the discard all that is left of Nature's scheme in that particular mouth. The surgeon, where convinced that the patient's interest is thus best served, does not hesitate to cut off a leg and provide for its replacement with the best possible artificial substitute. But he would not think of denuding a sound, healthy nether extremity of its normal contour, to be replaced by his own crude handicraft, because of an injury to a big toe.

Edwin H. Mauk, (Closing the discussion:) Lest my criticisms make me appear to be a common scold, I want to lay a well deserved tribute on the monument to American dentistry that has been erected thru all the years past, and which has had its apex,—perhaps not its apex but some of the top stones placed upon it during the war. Our American bridge-work, our American prosthesis, they are one and the same in the broader sense,—the things which have grown out of this art are the things that are saving many and many an allied soldier from permanent disfigurement, and we are going to feel this more keenly and appreciate it more fully when we see how it is going to save some of *our* men from permanent disfigurement. (Applause.) I wish that I were one of the mythical giants, an Atlas, capable of laying a stone so big upon that monument that its top could never be lost sight of.

I think that a little misunderstanding has arisen in regard to standardization. I have been working in pretty close harmony with Dr. Orton, and I feel that I am at liberty to state that his idea of standardization is not particularly a standardization of technic, but a standardization of principles, and that when we have the principles our technic will develop.

THE RELATION OF MOUTH CONDITIONS TO GENERAL HEALTH.

By Charles Mayo, M. D., Rochester, Minn.

(Given before the Minnesota State Dental Association, February 6-8, 1919.)

I WISH first to say that I am highly honored by the request of the officers of the Minnesota State Dental Association to present at this meeting an address on the subject of mouth infections from a medical standpoint. It is my intention not so much to talk to the dentists, as to speak for the benefit of that small member of society, the child, a subject on which we seem to be in hearty accord. It is not necessary that the dentists of the Northwest should be told how to conduct their business. We have in the middle West the best dentists in the United States. We have here at our University a great school, I don't believe there is any question of its being the best in the United States, and that means the best dental school in the world.

I wish further to state that we of the medical and lay professions are deeply grateful for this opportunity to meet the enlightened and progressive members of the dental profession of Minnesota, men who believe in the art and science of their profession sufficiently to attend such meetings, and who are also desirous of being active participants in all measures that tend to the development of their calling. A few years ago in an address at one of the Dental Association meetings held in Chicago, I talked on preventive medicine and said that the next step in preventive medicine was up to the dentists, and propounded the question, "Will they do it, will they make good?" And I wish to say tonight that they have within the last four years made more progress in their profession than the members of any other profession in this country. I will give them that credit.

One hundred years ago the neglect of dentistry by medical men led to its development as a special study, yet the relationship was recognized by some. Dr. Benjamin Rush, one of the men who signed the Declaration of Independence, reported a case of rheumatism which he cured by the removal of a diseased tooth. I have always believed that dentistry should have been a legitimate branch of regular medicine, since it is quite as important that dentists should have a general knowledge of disease as it is that physicians, who, after graduating turn to the specialties of the eye, ear, nose, throat, skin and other similar divisions, should have it. While it is true that the dentist should refer many patients to the physician for medical examination, it is also true that the physician should refer many more to the dentist for the good of the patients.

At a meeting of the National Association of Dentists a few months ago 7,500 members registered. This is 2,000 more members than are usually in attendance at the meeting of the American Medical Association, and when we realize that there are less than 47,000 dentists in the United States, it certainly

indicates the most encouraging enthusiasm and interest.

The home of dentistry is in this country, and the memory of William Black, the father of modern dentistry, has been perpetuated by a statue erected by the National Association. There can be no disparagement of the only profession that has been received with honor thruout Europe, where on every hand one sees the sign "American Dentist." The American army was the first to have its dentistry taken care of. Our chief, General Logan of the Surgeon General's office, was instrumental in increasing the number of commissioned dentists from one for one thousand to one for five hundred enlisted men. Thus the mouths of our soldiers that were shown to be so much in need of hygienic treatment were adequately cared for.

The dentists deserve great credit for having created the Research Institute of the National Dental Association from their own funds, recognizing that only by research can any advancement in the profession come. I was greatly honored by being made a director of the Association. Heretofore, there has been but little research in this line. The few institutions standing out prominently as doing this work are the Forsythe Laboratories in Boston, one in Rochester, New York, that was developed by the generosity of Mr. Eastman, and one in Rochester, Minnesota supported by the Mayo Foundation in affiliation with the University of Minnesota. This work is not intended to include general dentistry. It is conducted primarily for the purpose of research, and to show how the best service can be given. No dentistry is done, only the surgical work required when diseases are found to be caused by focal infections. The dental research work conducted by the University of Minnesota by Professor Hartzell was made possible thru funds donated by the National Board of Dental Research.

Dentists have then, to a great extent, taken the place with the people of the old family doctor who has disappeared, and their clientele calls on them at regular intervals for examination and advice. In the great progress and broadening out of medicine it has become impossible for any one mind to grasp the science in its entirety and to be able to practice dentistry with full justice to the sick, as was done a few decades ago.

Team work and organization only will make new medicine possible. We have approximately 140,000 physicians licensed in the United States. The laws passed in the various states to raise the standards of medicine were brought into effect wholly by the efforts of the medical profession. These laws were undoubtedly for the benefit of the people. Of the total number of physicians registered, many thousands were incompetent, many thousands were old or retired, but of the active members, 35,000 joined the army. These, with the dentists who enlisted, made the army life from the training camps to the dangerous fields of battle in France, a safer life than that of the civilian.

War has done much for the world, and especially for the United States. It is almost unfortunate that it could not have continued for at least another four months, as we were on the verge of a wonderful national unity with methods planned for the amalgamation of our foreign population into true American citizens. Among the many valuable lessons learned, none has been more valuable than the knowledge obtained by General Crowder's five thousand examining boards for the draft, on each of which were one or two of the older physicians. As a result of these examinations it was shown that more than 31 per cent of our young men in the third decade of life were physically unfit to participate in army life, and that the causes of these defects were largely preventable. In some states hundreds of young men were incapacitated

because of contagious trachomatous eyes, and in some states many thousands had hook worm and various other diseases.

The American people were appalled by the proved conditions reported from the camps with regard to minor defects due to preventable disease, to say nothing of the fact that an enormous number of soldiers were obliged to sign their names with a cross, and that many thousands born in this country could not speak the English language. This shows some of the defects of democracy in which the average thought is only that of the average people, and it indicates what is necessary in the effort to amalgamate our people. They must be protected as to their health, they must be educated, and later they must be given a living wage in order that they may be happy and self-respecting and thus of value to themselves, to the state and to the nation.

For many years the medical profession labored alone, almost fruitlessly, for pure water, for pure milk, for the better sanitation and hygiene of the homes, and for the protection of the industrial worker against preventable accidents. Within the last few years labor has become a power, and the industrial workers themselves have improved their conditions. Because of the rapid and expensive turn over of labor with its shortage and its high costs, they have had willing support from the managers of industry. These are changes which are only fair and just, and in accepting them we shall not be driven to make them in our more thickly settled communities by that tyrant against law and order, Bolshevikism. Our entrance into the war came just in time for national reorganization.

Good health is an essential to happiness, and happiness is an essential to good citizenship. In America too much of our educating is done at the top and at a time when people are too old to accept changes. Bismarck said, "Give me the child from seven to fourteen to educate and I don't care who has him afterwards, they will not change his early training." This is a true statement and indicates a re-organization of our educational system, which has remained unchanged for many generations. In other words, we must advocate vocational education. The student has the right to be educated along the lines of his adaptability, and thus be enabled to make a living. Insofar as possible during the period of his education, his health should be protected, since his knowledge of how to do this for himself is as deficient as it is of any other branch of education.

The problem before us is to make an effective appeal for better conditions in the lives of the children to the responsible and tax paying persons, many of whom have no children or whose children are now grown. The appeal should be made especially to people who did not themselves have such advantages and who are proud or complacent over the position they now occupy in society without it. In this connection it is always best to appeal to the women of the nation, who have indeed become a power. Baby welfare publicity must come; it should be made an essential part of the education of girls and mothers. In Minnesota the baby mortality rate is low, yet it is twice as high as the mortality rate of our soldiers in France. An unhealthy child makes a poor student whose frequent absence from school and backward education makes him more readily susceptible to criminal influences.

Children pay little attention to mouth cleanliness, especially to the care of the teeth. Parents did not receive much dental attention and they do not realize the need for this care of their children. Medical inspection is now an accepted part of the school curriculum, and in the large cities some dental inspection and care is also given; medical

inspection protects others against infectious diseases while the work of the dentist is for the good of the individual. The school nurse is an essential to a good school in order that the health work may be carried on effectively.

A certain degree of socialized medicine is inevitable for the future; it is for the good of the child during his school life, for the good of the poor at all times, and necessary for great industrial organizations. Beyond this, such care, except temporary charity as a gratuity, tends, I believe, to lower the standard of self-respect of the citizen. It must be difficult to maintain one's standards while compelled by various vocations to live from gratuities, and yet the tipping system is increasing thruout our country. Our legislatures and congressmen will be largely to blame for the results that accrue from the legislative tipping of our glorious soldier boys who are now to have their patriotism placed on a monetary basis. We, the people, are also the state, and while we must admit that there may be a great disparity in the income results of labor, the fundamental cause exists in the failure in the education and care of the people of the nation during childhood or the education and protection of immigrants.

The allotted years of man are three score and ten; a few men live longer, but a vast number live a much shorter period. Largely thru the efforts of preventive medicine during the last three decades, about twelve years have been added to the average life. While more persons do not reach old age, more do reach middle age, and the greatest gain is made in saving the lives of mere babies. The cause, then, for the high death rate of persons between forty-five and sixty years becomes of the utmost interest to us. Why do we often read or hear of men dropping dead on the street or being found dead in bed, over fifty-three years of age? An enormous number of such deaths were caused largely by preventable conditions due to the mouth.

Bacteria must have their own field for growth. Upon the farm the seed of the smart weed grows upon the black soil, when wet; but after the farmer has tilled it, and drilled it and cultivated it the smart weed will not grow; the bacteria necessary for its development have been destroyed. The sandburr is blown over the fields, and if it lights on the wet, black soil that fed the smart weed, it will perish and die; it needs the dry sand. The bacteria so necessary for it are found only there. These bacteria keep reproducing themselves, they constantly divide and multiply if they have the particular food necessary for their development, but as this food becomes exhausted they ultimately destroy themselves.

For centuries past, the history of man, his civilization, his wars, and his study of medicine record the same diseases we have today. The few new ones may possibly not be new, but only conditions recognized and separated from confused groups by greater diagnostic skill and knowledge. The description of symptoms has been recorded and passed on, enabling the various diseases to be recognized. Disease was thus studied as a whole in its effect upon the individual. And we thus have the different methods of treatment, Christian Science, osteopathy and various others; and I admit I tolerate these because it is necessary to have different methods of meeting and treating the different types of persons. There are lots of people who think they are sick and who are not sick. Laws should be enacted requiring a fundamental knowledge of general medicine and of disease, of chemistry, physiology and anatomy; only those who have such knowledge should practice medicine.

The old struggle for existence has caused a great change in the face bones. From lack of use the jaw has gradually receded, and instead of the protruding

jaw of prehistoric men with space enough for all the teeth, our last molar or wisdom tooth is now almost crowded out. They do not help us in eating our food at all. We do not need them, they are often impacted or do not erupt. With the modern preparation of fine flours and foods without enzymes or husks, in a short time we probably will be like chickens and require gravel in the place of teeth.

Since the discovery of the microscope, progress has been made in the exact study of the changes which take place in the individual cell. The cell is the basis of all life, its life action being a chemical one or a response to an irritation. The new basis of study has advanced our knowledge of disease in its effect on certain cells of multicellular life and has led to the discovery of the larger types of unicellular organisms. Staining effects on secretions and tissues have disclosed the unique world of unicellular organisms—the true chemists of the world, the builders, scavengers, destroyers or converters chemically of both organic and inorganic structures, which are truly the first life in the world, immortal and without which universal life would cease. These bacteria which exist so universally are always ready for action in suitable environments; those in the air are ready to carry on their chemical work in decaying vegetation, in causing infections, in making vinegar, alcohol, yeast for bread raising, in souring milk, curdling the various cheeses, and for countless activities.

Life does not occur without life. Unicellular life exists without death. To multicellular life death comes as a natural limitation to both plant and animal that are given the power of regeneration in perpetuation, altho their death may be hastened by unicellular destruction. The life history of but few of the countless types of microbes of the world is known. Many of these which expend their activities in the body locally or generally are well known in their relation to disease, and if they are not controlled or directed for good they may run riot in destruction.

In agriculture the bacteria are soil solvents, also converters of nitrogen in the soil or from the air for plant growth, in result, much the same as those obtained by men electrically. Soils are controlled by adding moisture or removing it by tile drainage, by adding lime or various fertilizers which change the possibility of plant life by changing the environment for myriads of soil inhabitants. The agriculturist or horticulturist has a working knowledge of many microbes that cause disease of grains, trees, and plants; the rusts, scales and fungi of destruction which are prevented and treated by sprays and fumigation should disease occur. The government spends millions of dollars in this work, and in the effort to prevent foot and mouth disease, hog cholera, tuberculosis, anthrax, spotted fever, hemorrhagic septicemia, and many other diseases. If this work were wholly effectual it would save our country billions in wealth each year.

Infection of another form is transmitted by insects in which the insect serves as a temporary or intermediate host for a transitional development, for example, of lice, mosquitoes, ticks, and so forth. Here again the government spends millions in eradication and prevention. One thousand dollars is spent in the protection of the animal life of this country to one dollar for the protection of human life. There is but little question that the government, like the law, is readier in the protection of property than in the protection of human life, and theoretically we, as a part of the government, should have the knowledge to protect ourselves; therein comes the need for education and opportunity. We have as portals of entry for the disease germs which afflict the body, the mouth, the openings of secretion, wounds, both

punctured and incised, and the bites of insects. The mouth is the great portal of entry of germs from the air, food water, and filth. In civilized countries the insect carriers of disease are fairly easy of control, yet the clothes louse was a great trouble to our army as a carrier of typhus, trench fever, foot disease, and so forth. The yellow fever mosquito carrier is on the verge of extermination. General Gorgas, whose work made possible the construction of the Panama Canal by converting a pestilential area into one of the safest zones, is now in South America with a group of scientists sent by the Rockefeller Foundation, endeavoring to eradicate the yellow fever from the world for all time. Science and education have done much but education still lags.

I shall not discuss the general diseases, such as fevers and infections so well known to all of us, nor the effects of the chemical destruction of bacteria in wounds with their toxins, further than to state that the cure of any disease or infection depends on the reaction of the body in fluids and cells to the irritation which develops so-called antibodies or chemical solutions as germicides or cells as destroying agents of bacteria with an increase of repair cells.

Bacteria have a definite chemical formula. Carrel and Dakin, as a result of war work and research, developed chemical solutions which, under certain conditions, combined with bacteria and destroyed them while forming other chemical compounds without the destruction of tissue. The well known facts concerning the immunity of the body, generated in the destruction of disease germs, which prevents the second acquiring of the disease were made use of in raising the threshold of body defense against typhoid. Colonel Russel deserves credit for his pioneer work in checking this disease in the American army. A moment's digression here is of importance in order to state that the great factor of disease which usually brought the wars of past ages to a termination was an unrecognized agent. Ill health was not a factor in this war because of the marvelous advance of the science of medicine. The prevention of disease was the most effectual the world has ever seen in war or civilian life. In the War of the Crimea 250 of every 1000 soldiers died of disease each year, in the Boer War the British had 9,000 deaths among 56,000 cases of typhoid. In our Spanish War we had 20,000 sick with typhoid in five months in the training camps; we lost 353 from injury and over 8,000 from disease.

Had it not been for our so-called influenza, the greatest plague the world has ever seen, medicine would have been supreme in its record in the great war. This plague caused more than six million deaths, many crippled, and great financial loss; more than 350,000 died in our own country. The excitement and lottery of war, however, prevented the panic that would have occurred at any other time. A study of the causes of death in influenza led to extensive use of the same methods of protection which have proved so effective in typhoid, tetanus and pneumonia. The reports of thousands of cases in which the vaccines and serums were used show the most gratifying results. The few who decried its use had little experience with the disease, did not use the remedy at all, or were ignorant of the methods of similar work in modern medicine.

The chronic recurring diseases of which men die in middle age have been the study of the last few years. In the past people were subject to rheumatism, spells of heart disease, recurring attacks of lumbago, muscular rheumatism, sciatica, or neuritis, iritis, hemorrhages in the retina, and so forth, due to mouth infection in the large majority of cases. They looked on themselves as extra-

ordinarily susceptible and felt sorry for themselves; they sent for the doctor to help them live more comfortably thru the period of expected disability, they visited the springs or sought a change of climate. Except endocarditis and bone lesions of children, which are principally caused by mouth infections, the diseases just referred to are diseases of middle life. They are bacterial in origin and the causative bacteria are those common to human and animal life. Nearly all who suffer from them have a small lesion or focus which from time to time delivers bacteria into the blood, and they are carried by the blood stream to the previously weakened vulnerable spot. Again the recurrent disease is produced and runs an acute or chronic course, developing immunity by reaction, and making improvement for an indefinite but not permanent period. The curious, sudden relief from maladies caused by such local foci of infection led to the recommendation of many eccentric remedies, such as the carrying or wearing of a rabbit's foot—the left hind foot I believe it is—dried potato, rheumatic finger rings, and the use of various dopes internally and externally, or, when the patient felt absolutely helpless from lack of knowledge and results, he took to prayer.

We are host to innumerable bacteria on and in the skin whose presence is recognized when continued irritation occurs. Myriads of microbes enter the mouth, and more than sixty varieties make their home there, not all at once, but in harmonious groups. Our intestines are always well supplied with microbes. The blood is also a field for harboring and transmitting a great variety of germs, but many of these organisms are harmless if they mind their own business in their proper place. In typhoid, pneumonia and other acute conditions, specific organisms are found in the blood, while spirochetes, malarial plasmodium, and many other organisms live in the blood for years, some giving but few symptoms. Some bacteria require the chemical affinity of the nervous cell tissue, possibly thru its high carbon dioxide content, and certain definite results occur from infection with the germs of poliomyelitis or meningitis which locate only in the nervous system. These create acute conditions, are destructive, and afford an immunity; others grow in nerve sheaths, joints, muscles and iris, and give recurring exacerbations after an apparent recovery. Such germs are harbored in the lymphoid tissue of the mouth, tonsils and adenoids, but because of increased opportunity they develop more often in diseased gums, dead nerve pulps of teeth and apical or root abscesses. In fact the tonsils are often infected from bad teeth. There is no pain in the tooth with a dead nerve. The bacteria are pumped by pressure into a vein, occasionally into a lymphatic, delivered into the blood stream, and carried about the body to be thrown out of the system, destroyed, or to locate in a vulnerable tissue which will become more susceptible to recurring attacks from a similar cause. The devitalized tooth, the crowned tooth, and the tooth with a dead pulp are a menace, and are now under investigation experimentally and clinically.

Our system may at times become allergic to bacteria of certain types, as each type requires a biochemic factor in order to obtain a foothold; once located, however, they prepare their own chemical environment, and are most difficult to dislodge without the surgical removal of the involved tonsil, tissue or tooth. Rosenow, in cases of acute hemorrhagic gastric ulcer, acute appendicitis, neuralgia and myositis, has been able to reproduce the lesion in animals by injecting cultures of bacteria taken from diseased teeth, from infected cavities and from pyorrhea.

The greater number of persons between the ages of fifty three and sixty

who drop dead, or are found dead in bed, are not the patients known to have heart disease but those who have chronic, painless infections that have caused a bacterial involvement of the heart muscle, and in whom the nerve nodes of the heart may at times become a sudden associated factor of danger. To discuss these questions with older persons who are affected in this manner will do very little good unless they are really sick or unless we can stir them up to help prevent similar trouble in their children or the children of others.

About 85 per cent of children have infections of tooth, tonsils, or adenoids, curable and preventable. William Black has said that one-fourth of us have septic mouths at twenty-five years of age, at forty-five nearly 90 per cent are septic and after fifty practically all mouths are septic. In the examination of the higher officers in Washington for overseas service, I usually found that those with good dentures were well, and that those with bad dentures were not well, and showed the effects of chronic infection. They were usually debarred from foreign service.

We must at least do what we can in our own communities for the betterment of the child. Every large school system must have the school nurse, and a whole time health officer who can, with the volunteer aid of local dentists which is always to be obtained, look after the examination of the children. I have never had any trouble in Rochester in securing free examinations and glass fittings, and free operations on tonsils and adenoids or teeth for all poor children. It is inevitable that medicine will become more or less socialized as it is in England, and justly so, for the care of the children and the care of the poor. Old age, health insurance, the workmen's compensation insurance, and pension will also come, but such organizations are not satisfactory as a cure. Their aim is to enable people late in life to recover from the bad educational conditions or unnatural conditions of labor incurred in their youth. Our nation's obligation is to give the same care and expense to the maintenance of the health of our people as it is now giving to agriculture, animal husbandry, commerce and labor.

Medicine in Washington, is now a charity, conducted under about eighteen bureaus and boards, including all the cabinet officers, none of whom will relinquish his control or co-ordinate the work; thus, as a whole, their endeavors with medicine are small and inadequate. We need a cabinet officer of Health.

METALLOGRAPHIC PHENOMENA OBSERVED IN AMALGAMS.

By Arthur W. Gray, Ph. D., Milford, Del.

(Transactions of the American Institute of Mining Engineers, Milwaukee Meeting, October, 1918.)

PHENOMENA which reveal chemical and physical processes that probably go on in many alloys at temperatures not far removed from their melting ranges are observable in dental amalgams. These amalgams should, therefore, be of even more interest to the metallographer, the metallurgist, the chemist, and the physicist than to the dentist who uses them for saving decaying teeth. For this reason I am here describing a few of the results recently obtained during the course of a systematic investigation of dental alloys.[1]

In order to keep this account within reasonable bounds, I shall confine myself almost entirely to the consideration of strength in compression (crushing strength) and of dimensional changes during hardening (reaction expansion). Conditions influencing the mercury content[2] will receive some attention. A few results have already been communicated to the American Physical Society.[3]

[1]In this investigation I was assisted by Paris T. Carlisle, 4th, and by Miss Martha C. Borton. To both of these I am greatly indebted for the care with which they looked after the numerous experimental details and records of some thousands of tests, the routine measurements for which were made, as a rule, by young women who were trained specially for the duties assigned to them.

[2]This term is here used to mean the per cent. of mercury in an amalgam. See p. 517.

[3]A. W. Gray and P. T. Carlisle: The Influence of Temperature upon the Crushing Strength of a Dental Amalgam. Rochester meeting. Phys. Rev. Vol. 11, P. 194; 1918. The Influence of the Pressure and the Time Employed in Condensing a Dental Amalgam upon its Crushing Strength at Temperatures between 10° and 100°C., Pittsburgh meeting; unpublished. The Influence of Amalgamation Variables upon the Mercury Content and the Crushing Strength of a Dental Amalgam. New York meeting. Phys. Rev. Vol. 11, P. 492; 1918.

I. CRUSHING STRENGTH.

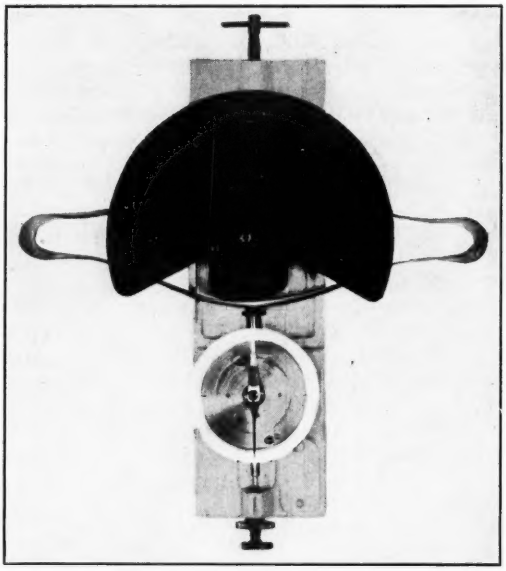
1. The Black Dynamometer.

Practically all strength tests of dental amalgams have heretofore been made with the spring dynamometer devised by Dr. Black.[4] The specimens tested were in the form of cubes 0.085 in. (2.16 mm.) on each edge. They were prepared by packing the amalgam into split steel molds essentially as it would be packed into a tooth cavity, sometimes with simple hand force, sometimes with blows from a mallet. The cubes were crushed at whatever temperature the room happened to offer, and the mean of several trials was taken to represent the strength (Figures 1 and 2).

Every physicist will recognize that, while such tests may be of great value in pioneer work, they are hardly likely to yield results having the accuracy desirable in modern research. The cube, with its sharp corners and its radial asymmetry, is not the best shape for a test specimen. The particular cubes used with Black's dynamometer are so small that the accidental errors arising from unavoidable irregularities in shape, size, and internal structure may easily render the results uncertain. Their smallness introduces an error owing to the restraining action of the jaws between which they are crushed. Temper-

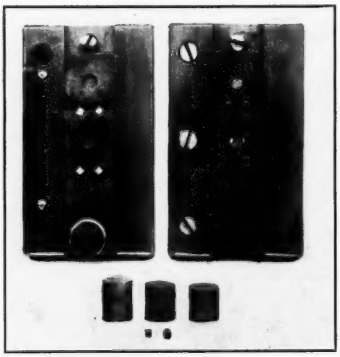
[4]Dental Cosmos, Vol. 37, P. 406 ff; 1895.

Figure 1.



Spring dynamometer devised by Dr. Black for testing crushing strength and flow of Dental Filling Materials.

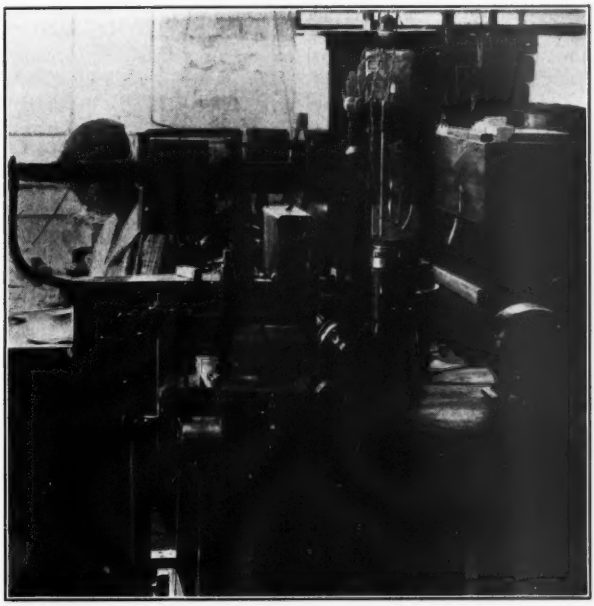
Figure 2.



Molds for preparing 0.085-in. cubes of amalgam tested in Black dynamometer. Below are shown relative sizes of cubes and cylinders used for crushing tests.

ature affects the stiffness of the spring used for measuring the crushing force; it also affects considerably the strength of a dental amalgam. The strength of an amalgam specimen is also largely dependent upon the pressure under which it is molded into form; the hand or mallet packing cannot control this pressure sufficiently well for accurate comparisons of different alloys.

Figure 3.



The 9000-kg. Olsen machine adapted to testing strength of materials at any temperature and provided with power drive for applying testing load with regularity.

2. Standardized Procedure for Crushing-strength Tests.

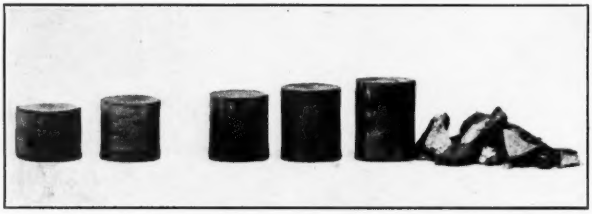
I have, therefore, discarded the old Black dynamometer in favor of a 9000-kg. Olsen testing machine, which was designed for operation by hand (Figure 3). This I modified by the addition of an electric motor drive which applied the load with regularity, thus permitting the beam to be kept balanced to a nicety right up to the moment of failure; and by the addition of electric heaters for bringing the specimen under test to the desired temperature, which was determined by a suitably placed thermo-element. Additional thermo-elements enabled temperature gradients within the heated region surrounding the cylinder to be adjusted to negligible values. The electromotive forces were measured by a potentiometer.

The test specimens were in the form of right circular cylinders 10.04 mm. in diameter and of sufficient height to eliminate errors caused by the restraining action of the crushing jaws (Figure

4). These cylinders were prepared by molding the freshly mixed amalgam in a thick-walled steel tube, the interior of which was highly polished. A measured force, applied by the testing machine and maintained for a measured time, was used in packing the amalgam between an accurately fitting piston and the removable bottom of the mold. This packing squeezed out the excess of mercury and condensed the plastic mass into a firm, smooth cylinder with parallel ends. The procedure secured both uniformity of cross-section and uniformity of packing conditions.

during the testing. To save time in reaching the general conclusions desired, no attempt at controlling the temperature of the specimen during crushing was made in these earlier tests; the tests were made at whatever temperature the room happened to offer. As a consequence, the accidental errors, measured by deviations from average values, were often considerably larger than in the later tests, in which temperature and other influencing conditions were carefully controlled. Even the preliminary experiments demonstrated the need of a thor-

Figure 4.



Test cylinders of amalgam prepared by amalgamating 6¹ gm. alloy. Cylinders A and B from low-silver alloy compress and crack. Cylinders C, D, E, and F from high silver alloy burst explosively. Cylinders B and D, both packed under 400 kg., show difference in size of amalgam from same weight of alloy. D is 25 per cent. larger and 75 per cent. stronger than B. C, D, and E are packed under 141, 400, and 1131 kg. per cir. cm., respectively. Natural size: 10.0 mm. in diameter.

Many preliminary experiments were made to obtain a general idea of the ways in which different conditions may influence the crushing strength of a dental amalgam. These experiments showed the effect of variations in such factors as the proportions of mercury and alloy used in mixing the amalgam, the time devoted to triturating the mix, the temperature of trituration, the pressure under which the amalgam is molded into test cylinders, the time that this packing pressure is maintained, the height of the test cylinder, the time that elapses between the making and the crushing of the cylinder, the temperature at which it is stored during this interval, and the rate at which the crushing load is applied

oly standardized technic if results of real value were to be obtained.

3. Influence of Height of Test-piece Upon Apparent Strength.

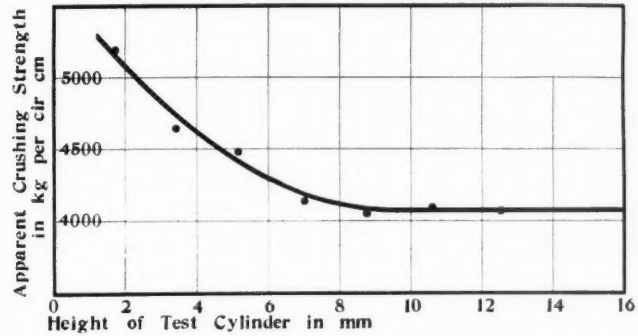
In short-column tests it is important to have the test specimen sufficiently high to eliminate the effect of friction between the crushing jaws and the specimen; otherwise the apparent strength will be greater than the true strength of the material. Therefore, one of the first things to be determined was the minimum height allowable with amalgam cylinders 1 cm. in diameter. About 9 mm. was found to be ample; reduction to 6 mm. would not introduce serious

error (Figure 5). However, no cylinders shorter than 10 mm. were ever used.

4. Influence of Packing Pressure and of Packing Time.

The next points to be decided were the influence of packing pressure and of packing time upon both the mercury content and the strength of a high-grade amalgam.[5] The pressures used in packing were systematically varied from 25 to 3200 kg. per cir. cm.;[6] and the time during which a packing pressure was maintained was varied from 1 to 16 minutes.

Figure 5.



Test specimens that are too short make material appear stronger than it really is.

The time of packing was found to exert but little influence upon the crushing strength,[7] especially when the packing pressure was low. Our earliest experiments indicated that it would be safe to standardize upon a packing time of 8 min. in order to eliminate possible irregularities arising from this source. Later tests under controlled temperature showed the advisability of reducing the time to 4 min.; still later ones resulted in adopting 2 min. as the standard. The slight increase of strength observable when a high packing pressure was maintained for a considerable time seemed traceable to cold working. This view was strengthened by results obtained at higher temperatures. Dilatometric measurements of reaction expansion (which were found to be far more delicate indicators than results of crushing tests) showed but little change upon reducing the packing time to one-quarter of a minute.

The packing pressure was found to exert a marked influence (Figure 6). Even the earliest tests at room tempera-

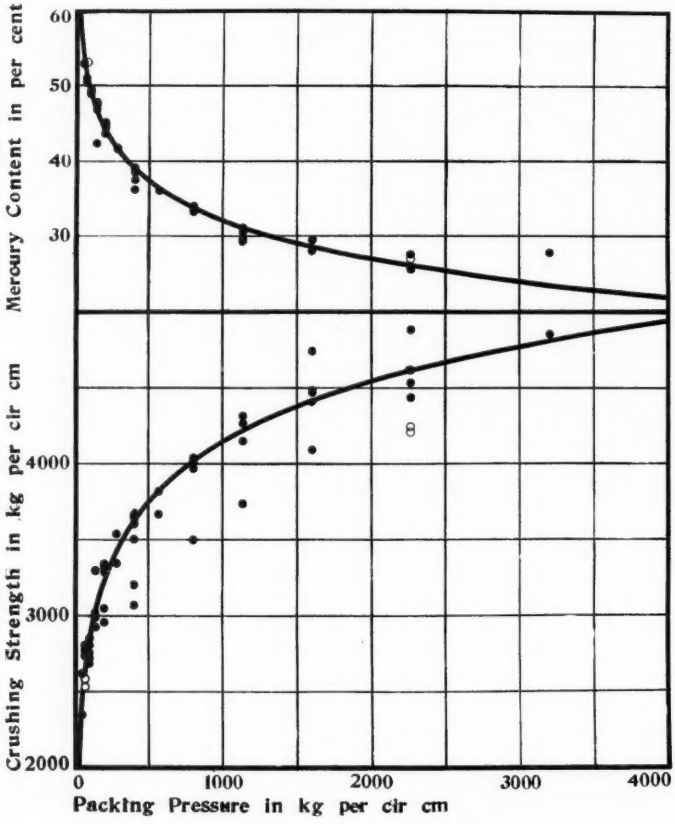
[5]The ratio of the masses of mercury and alloy that are mixed together to form an amalgam will be frequently referred to as the "mercury-alloy ratio." In the process of molding this amalgam into test specimens, some of the mercury, along with a small amount of alloy, is squeezed out by the pressure exerted thru the piston of the mold. The percentage of mercury in the finished test specimen is here designated as the "mercury content."

[6]For convenience, nearly all pressures are here expressed in terms of kilograms-weight per circular centimeter. 1 kg. per cir. cm.= # kg. per cm.^{2} =18.11 lb. per in.^{2} Black and his followers express crushing strength in terms of pounds-weight under which a 0.085-in. cube failed. Such a result must be multiplied by 7.6 to reduce to kilograms-weight per circular centimeter.

[7]Thruout this paper the term "crushing strength" is used to designate the pressure (almost always expressed in kg. per cir. cm.) under which the test specimen failed when subjected to simple axial compression.

ture showed that, other things being equal, the crushing strength S increases directly as the logarithm of the packing pressure P; so that, within the limits of experimental error, it can be expressed by a formula of the type $S = A + B \log P$, which is equivalent to $P = e^{aS-b}$, in which e stands for the logarithmic base, while A, B, a, and b, are parameters depending upon such factors as the nature of the amalgam and the temperature of crushing. At the same time, the mercury content was found to decrease logarithmically with increasing packing pressure; so that it, too, could be represented by a similar formula.

Figure 6.



Both crushing strength and mercury-content of an amalgam vary as logarithm of packing pressure. Large deviations from lower curve arise from crushing specimens at various temperatures.

The curves shown in Figure 6 were calculated from such equations. It can be seen that nearly all the points representing the results of the individual tests

lie close to the curves. A few, however, deviate by more than appears to be the uncertainty of our crushing tests. As was then assumed, and now confirmed by later experiments, these irregularities can be readily explained by the fact that the tests were made at room temperature, on different days during the summer, which resulted not only in different cylinders being crushed at widely different temperatures, but also in different amounts of moisture being condensed from the air upon the filings of alloy as they were being triturated with mercury. In addition, some of the deviations may have been due to the use of hand power in applying the crushing load, and to those occasional irregularities that seem inseparable from strength tests, such as defective specimens and failure to adjust properly between the jaws of the testing machine.[8]

The alloys used in all the other tests described in the second part of this paper were likewise amalgamated by trituration in a mortar, unless the contrary is stated. In most cases, however, 6 gm. of alloy were used, and changes were made in such factors as mercury-alloy ratio, trituration time, and age of the amalgam when tested.

The logarithmic law connecting strength with packing pressure now has the support of more than 4000 crushing tests of amalgams prepared under widely varying conditions. The only systematic deviations from it thus far observed were found with cylinders undergoing transition: either the mix had not completely hardened, or else it was softening from the transformation that occurs near 70° C. (see p. 525.) Even in these cases the deviations were only slight.

[8]Each cylinder used in the tests recorded in Figure 6 was prepared from 5 gm. of a high-grade alloy in the form of filings, just as furnished to the dentist. This was incorporated with 1.40 times its mass of purified mercury by thoroly triturating in a glass mortar for 1.5 min. The resulting amalgam was quickly rolled into a ball, dropped into the mold, and packed immediately. The cylinders were crushed 24 hr. after making.

5. Application of Logarithmic Law.

As soon as the law was discovered it was applied for checking and adjusting observations. Instead of following the usual engineering procedure of averaging the results from several tests of specimens all subjected to the same treatment, cylinders for testing a given point were always prepared in groups of three, or of five, packed under pressures increasing in geometrical progression. The pressures actually used were from the series 100, 141, 200, 283, 400, 566, 800, 1131, and 1600 kg. per cir. cm., in which $\sqrt{2}$ is the common ratio. Then, if the crushing strengths found for all the cylinders of a given group were plotted as equidistant ordinates, the points obtained should lie close to a straight line. This procedure yields just as good an average value as if all the cylinders of the group were packed under the same pressure. In addition, it yields the particular curve connecting strength with packing pressure that holds for the conditions under which the test is made. Its justification lies in the fact that, with the exceptions noted in the preceding paragraph, the logarithmic law has always been found to represent the observations within the limits of experimental error.

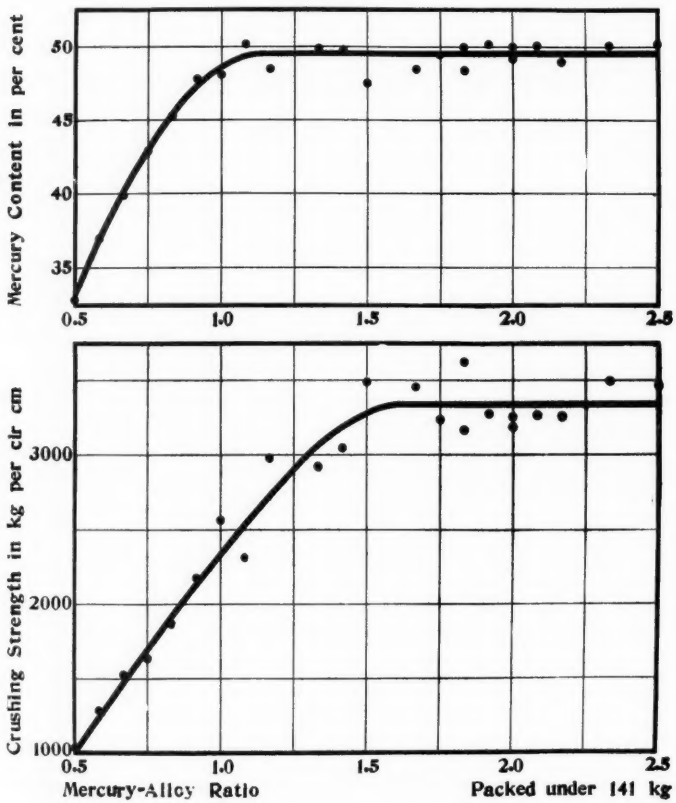
6. Influence of Amalgamation Variables.

The fact that both the strength and the mercury content change regularly with the packing pressure suggests at once a close connection between the former and the latter. Long ago, Black found that the more mercury he squeezed out during the packing of a given amalgam, the stronger was the filling he obtained; but his methods of experiment-

ing were not sufficiently precise to bring out any quantitative relationships. That the suggested connection is not of the nature of cause and effect, but is rather a coincidence resulting from a common cause, becomes apparent as we notice how strength and mercury content are affected by varying such factors as the mercury-alloy ratio and the trituration time.

Figures 7, 8 and 9 exhibit the results of varying the mercury-alloy ratio from 0.5 to 2.5, while the trituration time was maintained uniformly at 1.5 min. This varied the mix from a very stiff to a very pasty one. The cylinders packed under the lowest pressure (141 kg. per cir. cm.) show the phenomenon most clearly, both mercury content and crushing strength increasing rapidly in the same general way to maximum values, which remain constant as the mercury-alloy

Figure 7.

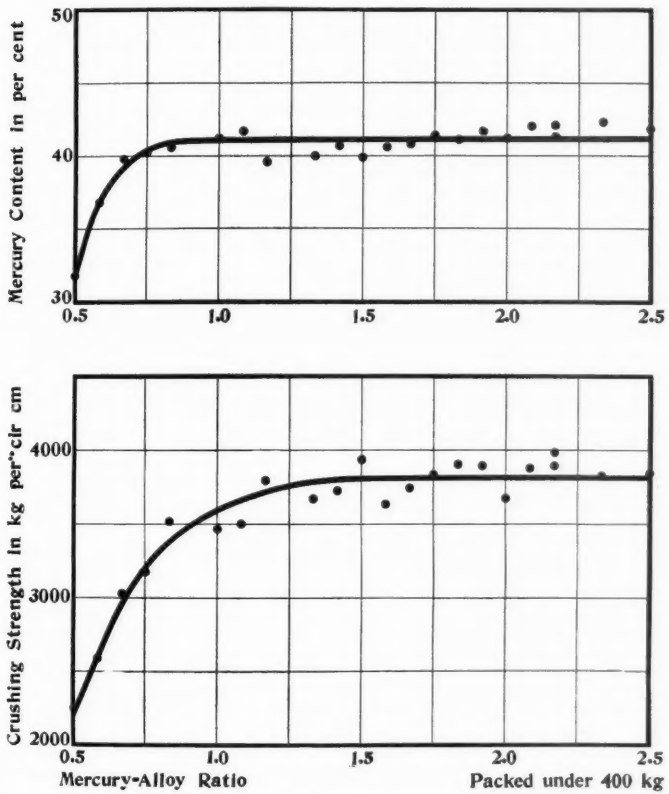


Effects of varying relative amounts of mercury and alloy that are mixed together in making an amalgam.

ratio is still further increased. The illustrations show how the increases of packing pressure progressively wipe out the effects and cause the maxima to be reached sooner; also, that constant mercury content is reached before constant strength.

Figures 10 and 11 exhibit the results of varying the trituration time from 1 to 8 min., while a constant mercury ratio of 1.40 was used. The curves of Figure 10 show that, in general, more mercury is retained in a test cylinder by prolonging the trituration; but it is interesting to note that when the packing pressure is low, less mercury seems to be left in the cylinder by increasing the trituration time from 1 to 2 min. Apparently this is because the shorter trituration leaves many of the alloy granules so large that a low packing pressure is insufficient to squeeze out the free mercury from the

Figure 8.

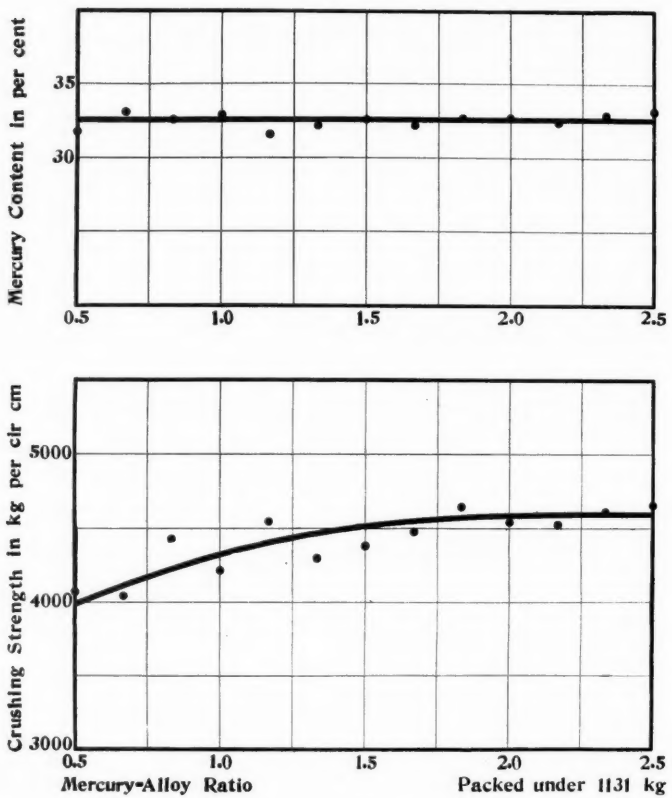


Modification of Figure 7 produced by increasing packing pressure from 141 to 400 kg. per cir. cm.

spaces among the solid particles. The curves also show that for a given trituration time the mercury content changes

ing the time beyond this brings about a very gradual falling off in strength on account of the incipient setting of the

Figure 9.



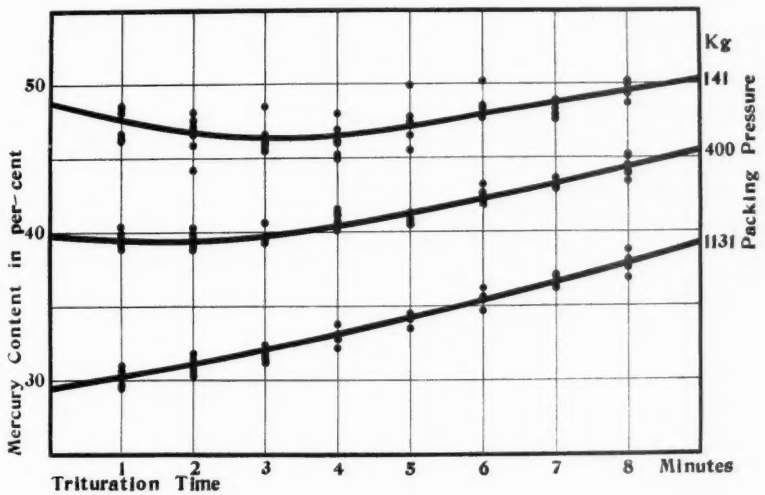
Modification of Figures 7 and 8 by further increase of packing pressure to 1131 kg. per cir. cm.

almost inversely as the logarithm of the packing pressure.

Increasing the trituration time while the packing pressure is kept constant is accompanied by a progressive increase in strength (Figure 11) until the latter reaches a maximum when the trituration is maintained for about 6 min. Prolong-

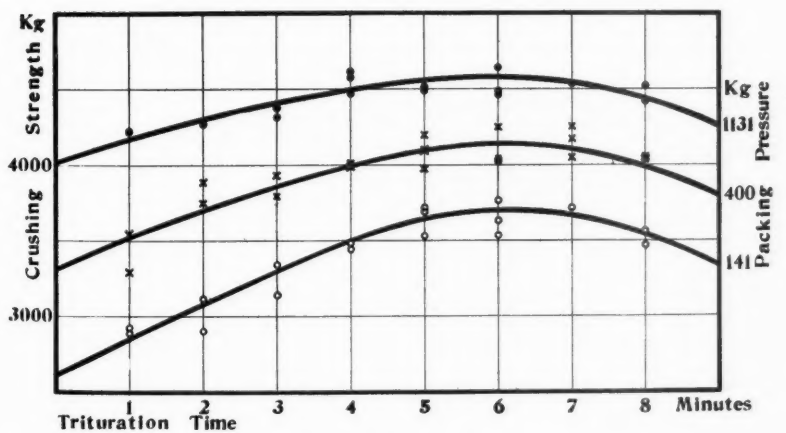
amalgam during the mixing. The results also indicate that the logarithmic law connecting crushing strength and packing pressure is applicable for any given trituration time within the range investigated. The reason why excessive amalgamation produces so little effect upon the mercury content would appear

Figure 10.



Changes in mercury content produced by varying time devoted to triturating mix of alloy and mercury.

Figure 11.



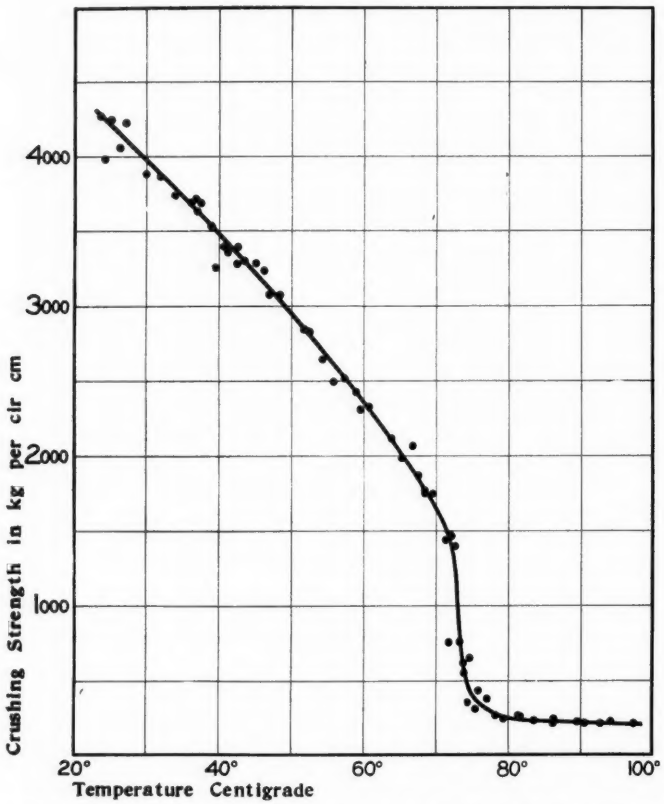
Gain in crushing strength produced by increasing trituration time.

to be simply that the metals entering into a dental alloy are only very slightly soluble in mercury.[9]

7. Influence of Temperature.

Figure 12 represents the results of crushing 63 similar cylinders of a high-grade dental amalgam at temperatures fairly uniformly distributed over the entire range from below 25°C. to over 95° C. Each cylinder was prepared by incorporating the same mass of alloy filings with 1.60 times this mass of mercury. After triturating for 4 min., the resulting smooth plastic amalgam was packed under a load of 400 kg. main-

Figure 12.



Effect of temperature on crushing strength. Transition region shown by the rapid fall in strength between 70° and 80° is confirmed by Figures 13 and 14.

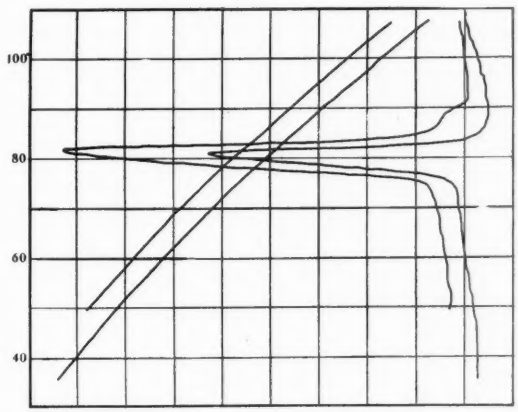
[9]McBain and Joyner (Jnl. Chem. Soc. London Vol. 99, P. 195-208; 1911; Dental Cosmos, Vol. 54, P. 646-648; 1912) analyzed mercury that had been saturated by two weeks' contact in a thermostat with fillings of silver-tin alloys, ranging by 10 per cent. steps from one pure metal to the other. They found that at 25°C the mercury dissolved but 0.044 per cent. silver and 0.75 per cent. tin, and that these saturation values were independent of the composition of the alloy. At 63°C., about 0.18 per cent. and 2.5 per cent., respectively, were dissolved. Even the most thoro amalgamation of dental office practice is hardly likely to bring about complete saturation.

tained for 8 min. This produced a cylinder 10.04 mm. in diameter by 11.5 mm. high, 40 per cent. of its mass being mercury. All the cylinders prepared in this way were immediately placed in an incubator kept at 37.5°C. (body temperature), where they remained for several days before crushing, thus insuring practical completion of the hardening process. The alloy used contained approximately 68 per cent. silver, 26 per cent. tin, 5 per cent. copper, and 1 per cent. zinc.

All the 63 individual determinations made on three separate days are included in the chart. The abscissa of a point represents the temperature of a cylinder at the time it was being crushed; the ordinate, the compressive load in kilograms-weight sustained by the cylinder at the instant of failure, and, therefore, the crushing strength in kilograms-weight per circular centimeter. The closeness with which the points follow a smooth curve shows the uniformity with which a dental amalgam can be prepared, and also the precision with which crushing tests can be made, provided proper precautions be taken.

The curve indicates that with rising temperature the crushing strength of the particular amalgam represented decreases somewhat faster than linearly from 5300 kg. per cm.^{2} at 25° to 4050 at 45°, and 2550 at 65°. At 37.5° the strength was found to be 4550 kg. per cm.^{2} or nearly 65,000 lb. per square inch.

Figure 13.



Transition region revealed by modified Roberts-Austen method. Temperatures plotted as ordinates are those of neutral body. Abscissas are galvanometer deflections. Diagonal curves show rate of heating neutral body, each horizontal space representing 20 min.

8. Transition Region Near 70° C.

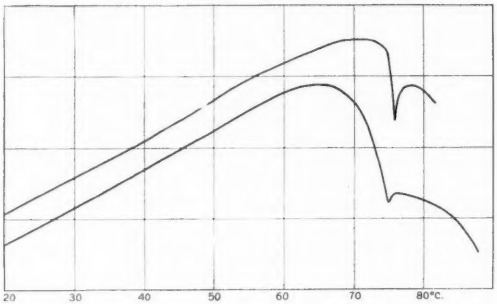
One of the most interesting features of this curve is the sudden plunge that it takes soon after passing 70°C. Black had observed that an amalgam, upon heating to the temperature of boiling water, suffered a noticeable permanent change in both appearance and volume, which he surmised was caused by something other than ordinary thermal-expansion.[10] McBain and Joyner, employing a liquid dilatometer in the usual way, located a sharp transition at 71.5°

[10]Dental Cosmos, Vol. 37, P. 661; 1895.

C.[11] I have confirmed the existence of this transition by means of two other entirely independent methods of thermal analysis.

Figure 13 reproduces typical curves obtained by a modification of the Roberts-Austen method of observing temperature differences between the sample and a neutral body while both were being heated simultaneously in the same enclosure. It is evident that the transition is accompanied by an appreciable absorption of heat.[12] The heating curves obtained with two cylinders packed for 8 min. under 141 and 1131 kg. per cir. cm., respectively, showed sharp peaks at essentially the same temperature, which was close to 77.3° C., corresponding to about the completion of the sudden drop in strength. The magnitude of the heat absorption was somewhat greater with the cylinder packed at the lower pressure which also contained a greater proportion of mercury. The beginning and the end of the transformation are not sharply defined, but are in the neighborhood of 70° and 90°, respectively. On cooling from 100° to 50° no corresponding evolution of heat was observed, showing that the transition is not a reversible one. The absorption of heat, however, reappears at about the same temperature with each successive warming of the same specimen; but the magnitude of the effect progressively diminishes.

Figure 14.



Transition region revealed by dilatometric method. Curves represent heatings of same specimen on two successive days.

Figure 14 reproduces a pair of curves obtained by a method that depends upon variations in linear thermal expansivity. The two curves show the effect of heating the same specimen on successive days. The modifications produced by the first heating and the reappearance of the sharp minimum should be noted. The amalgams represented by Figures 13 and 14 were prepared from different alloys

9. Influence of Packing Pressure at Various Temperatures.

Having learned how the strength of a high-grade dental amalgam could be altered by varying separately either the packing pressure or the temperature of

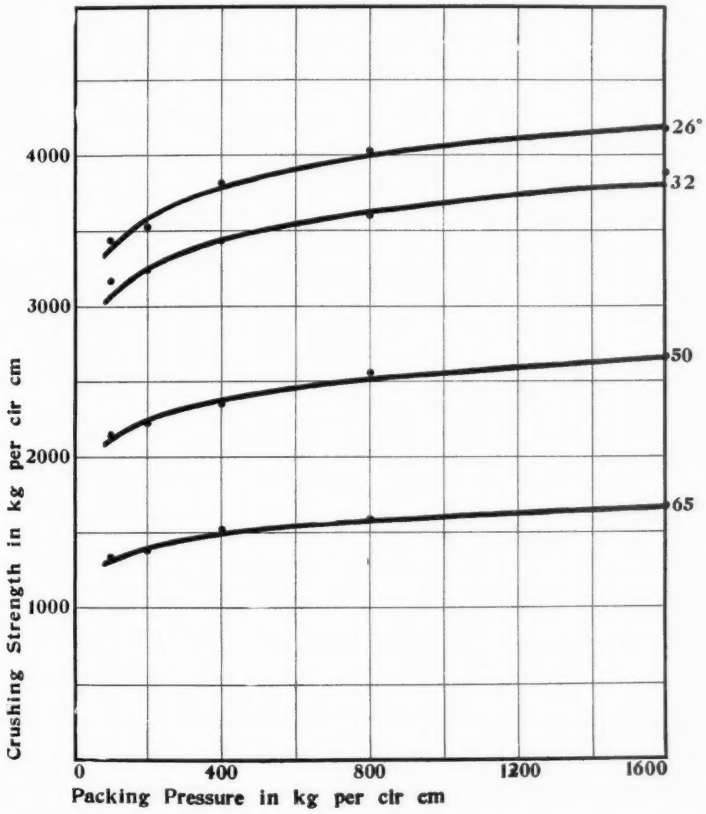
[11] Ibid., Vol. 54, P. 649; 1912.

[12] McBain and Joyner (Ibid., Vol. 54, P. 647) state that "Comprehensive series of cooling curves of the various amalgams were taken, but the chemical changes involved are too slow for this method to be advantageous. It was found that all amalgams of tin and silver, even those that have long hardened, undergo partial fusion at 65° to 100°, and gradually become more fluid as the temperature is raised."

crushing, it became of interest to investigate the effect of simultaneously varying both of these parameters within wide limits. Accordingly, a group of test cylinders were packed for 4 min. under loads of 100, 200, 400, 800, and 1600 kg. per cir. cm. After storing at 37.5° for 3 days, these were crushed at temperatures distributed over the interval from 25° to 100° C.

Some of the results are represented by Figure 15. The curve for each temperature was calculated from an equation of the type $S = A + B \log P$, in which the letters have the same meaning as on p. 518. The plotted points, each of which represents an individual crush (not an average of several tests), were located after applying small corrections to reduce the observations to what they would

Figure 15.

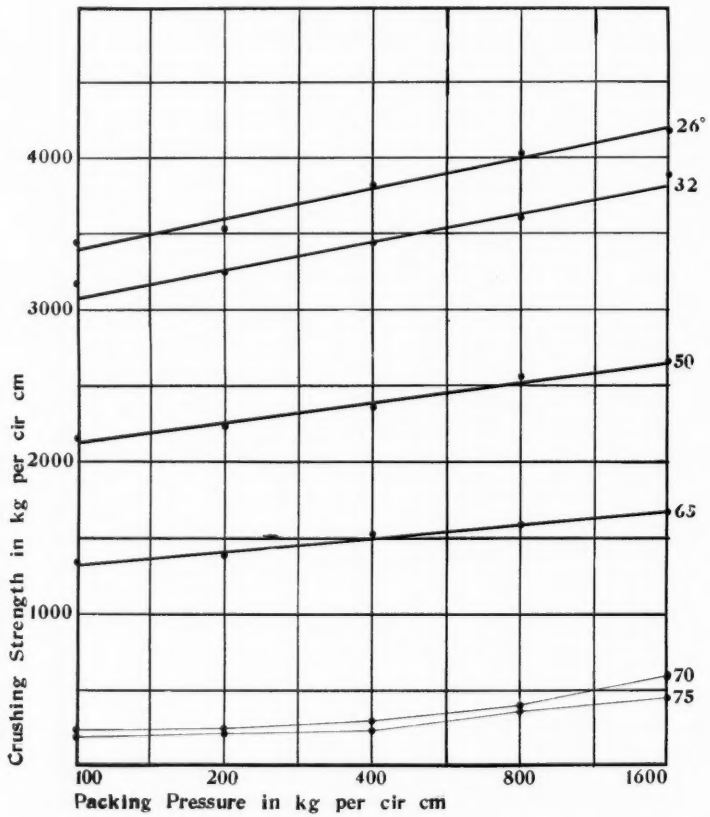


Logarithmic law connecting crushing strength and packing pressure holds at any temperature between 26° and 65° C.

have been if the temperatures at the time of crushing had been exactly those stated along the right-hand margin.

Precisely the same data are plotted in Figure 16. The only difference is that the curves of Figure 15 have been transformed into straight lines by the simple mathematical expedient of making the abscissas proportional to the logarithms of the packing pressures. The results of tests at 70° and at 75°, which are here added, indicate slight deviations from the logarithmic law at these temperatures; but these deviations are hardly greater than the experimental errors.

Figure 16.



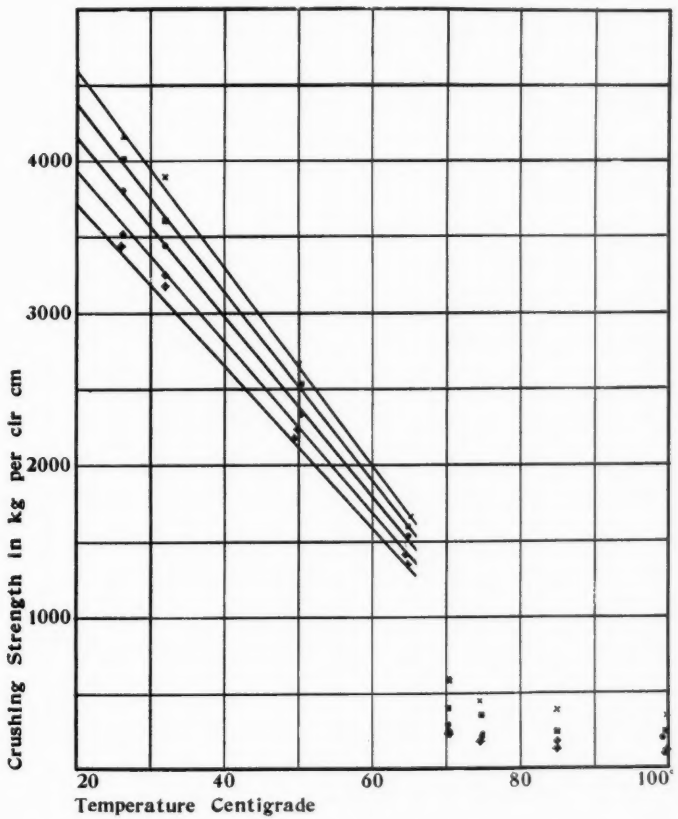
Transformation of logarithmic curves of Figure 15 by plotting abscissas proportional to logarithms of packing pressures.

Still another view of these same facts is afforded by Figure 17. Here again the straight lines (each of which corresponds to a definite packing pressure,

ranging from 100 kg. per cir. cm. at the bottom to 1600 at the top) result from direct mathematical transformation of the lines appearing in the preceding two figures, the logarithmic relations being expressed by the equal angular spacing. In this plot no corrections are necessary for temperature deviations from the nominal values. The points represent the actual observations, each packing pressure being indicated by its own symbol. Additional observations near 85° and 100° are included.

It is possible that the lines representing the results between 25° and 65° in Figure 17 should be slightly curved as in Figure 12. However, the straight lines, as drawn, afford a simple means of expressing the observed facts within the limits of experimental error. The

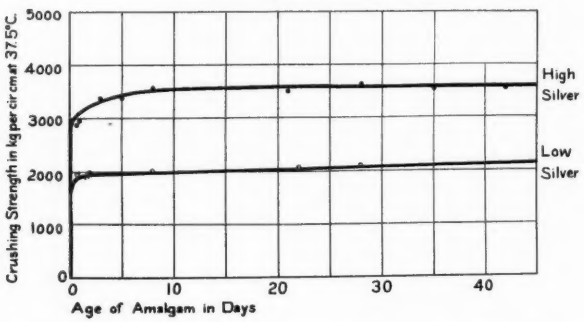
Figure 17.



Data represented in Figures 15 and 16 plotted to show that strength of given amalgam specimen decreases linearly with increase of temperature. Logarithmic law is expressed by equal angular divergence of straight lines corresponding to various packing pressures.

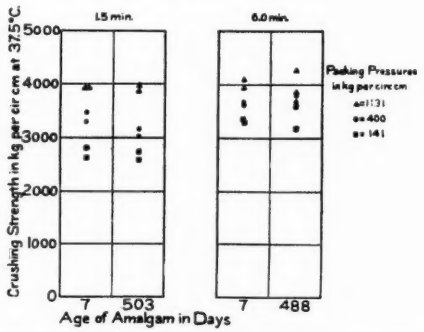
reason why the first part of the curve in Figure 12 lies above the median line of Figure 17 is to be sought in the fact that the cylinders used for the former changes with change of temperature. Perhaps this has some connection with the transition of tin from the white to the gray form.

Figure 18.



Hardening of amalgams. Amalgam from high-silver alloy is 75 per cent. stronger than that from low-silver alloy.

Figure 19.



Amalgams from dental alloy of good quality show no retrogression in strength during more than 1½ year.

were somewhat harder, because they were subjected to the packing pressure for 8 min. instead of 4, and they were stored more than twice as long before crushing.

Cooling the amalgam below 20° or 25° was found to result in a marked reduction of the rate at which strength

10. Influence of Age upon Alloy and Amalgam.

Two more questions of vital interest to the dentist will now be considered. (1) How does the strength vary with the time that elapses after the plastic mix is condensed into a rigid cylinder by the application of the packing-pressure?

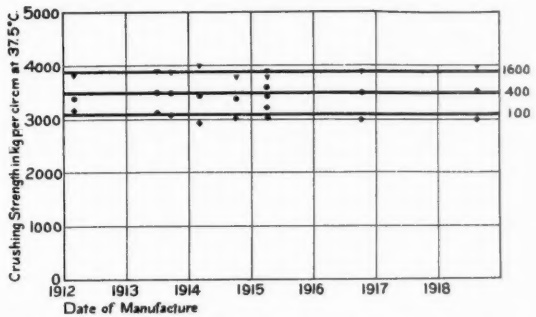
Does an amalgam, after hardening to its maximum strength, maintain this strength indefinitely? (2) Does the alloy from which the dentist prepares his amalgam deteriorate from long standing on the dealer's shelves?

In Figure 18, the upper curve shows the behavior of an amalgam from the same high-grade alloy that has been represented in the preceding charts; the lower curve shows the behavior of an amalgam from a typical low-grade alloy still much used by dentists all over the country. Both alloys were treated in exactly the same way; the cylinders had been packed for 2 min. under 400 kg. per cir. cm. The results with other packing pressures yielded similar curves, which are here omitted to avoid confusing the chart. For the same reason, those cylinders between 0.1 hr. and 6 hr. old are also omitted. Note the extremely rapid rise in strength during the first 2 hr., followed by a slow increase that continues for more than a week. Note, also, the striking difference between the high-grade and the low-grade alloy.

The stability of the high-grade amalgam is well brought out by Figure 19, which compares cylinders only 7 days old with others which had been stored at body temperature for more than 16 months before crushing. Whether the mix was triturated for 1.5 or for 6 min., whether it was packed under 100, 400, or 1600 kg., there is not the slightest indication of retrogression in strength. The results demonstrate conclusively that it is perfectly possible to make a dental alloy which will yield a stable amalgam.

Figure 20 shows the uniformity of product attainable in the regular commercial manufacture of a high-grade dental alloy. It shows, also, that the sample of alloy which had been standing in the package as long as 6 years yielded just as strong an amalgam as the sample which had been made only a few days before testing. These results prove beyond question that a properly made alloy does not deteriorate with lapse of time, provided it has been kept reasonably clean and has not been subjected to gross abuse such as storing in an unusually warm place.[13]

Figure 20.



Uniformity and stability of dental alloy of good quality. Figures to right of lines indicate pressures under which amalgams were molded into test cylinders.

[13]Ward conducted an extensive series of tests which led him to the conclusion that some, at least, of the high-silver dental alloys on the market show marked deterioration with time both before and after being made into amalgam fillings. Dental Review, Vol. 21, P. 416; 1907. Dental Cosmos, Vol. 50, P. 114-116; 1908. Jnl. Allied Dental Soc., Vol. 11, P. 446 1916.

(To be continued in a later issue.)

The Research Department
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THE NATIONAL DENTAL ASSOCIATION
CLEVELAND, OHIO

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President

A MEMORIAL HOUR TO THE LATE DR. JOHN R. CALLAHAN.

A BRIEF REVIEW OF HIS PROFESSIONAL ACTIVITIES.

By T. Irving Way, D.D.S., Cincinnati, Ohio.

(Read before the National Dental Association at Its Twenty-second Annual Session, Chicago, Ill., August 5-9, 1918.)

IT IS indeed a privilege to join with you at this hour in paying tribute to, and in this small way honoring that man who gave so freely of his time and ability, whose constant endeavor was to make for better service and a higher standard of the profession. Dr. Callahan's dental activities began early in life. His father, a physician and dentist, was associated with Dr. John Ellis in the practice of dentistry in Hillsboro, Ohio, in the early seventies. Under the direction of these two men he began the study of dentistry. He later entered The Philadelphia Dental College and was graduated from that institution February 27th, 1877, receiving the degree of Doctor of Dental Surgery.

After his graduation he began the practice of his profession in San Francisco, Cal., as the associate of his classmate, Dr. Washington G. Winter. Two years later he returned to Hillsboro and continued the practice of dentistry in that village until 1890 when he removed to Cincinnati, Ohio, where he succeeded to the practice of Dr. C. R. Taft (brother of the late Johnathan Taft.)

To him the practice of dentistry was a tremendous responsibility, whether in the village or city, thruout his entire career he was an earnest advocate of the "Dignity of Service." Coupled with his unusual ability he established and maintained a practice of the most desirable character.

One of the highest testimonials to a professional man's worth is that of an appreciative Clientele whose loyalty extends over a long period of years. This

was accorded Dr. Callahan in full measure.

The following tribute from a friend and patient expresses the feelings of the many he served so faithfully and well.

"The mind and temperament of Dr. Callahan seem to have been rarely well suited to his chosen task of securing for his fellow-men all those services of a science which his patient study had mastered. Lucid and inflexible in pursuit of truth, yet was his mind tempered by a kindly sympathy that had almost a women's tenderness in the offering of that helpful service for which he was so richly equipped. To patients he endeared himself furthermore thru a wholesome interest in their occupations. With him in confidence the young, ambitious, mechanical engineer talked over his plans. The poor little girl in the hospital, whose treatment had been severe and painful chatted with him in enjoyment of her "nice new dress." The sensitive woman, with nerves too high-strung he quieted with a word, firmly but kindly spoken. It was all very definite and clear, whether the professional advice and treatment or the friend's kindly interest. There was a subtle delicacy in his strength which anyone could see who watched the very expressive movements of the perfectly controlled fingers of his remarkable hands,—in themselves highly characteristic of the man. While listening to him talk, my eyes were wont to watch his hands, so expressive were they of the spirit of his speech. As I know it did to many others, his friendship meant very much to me in hours of pleasant relaxation and in times of perplexity and trial, and I shall always treasure the recollection of it."

Dr. Callahan's professional activities were not confined to the daily routine of his office. To have a part in the growth and development of dentistry was as much a part of his life work as the practice of his profession. He was active in National, State and local societies. Entering practice in Ohio in 1879—he became a member of the State Society in that year. Taking a lively interest in its affairs, in 1884 he was elected Secretary, which office he held thruout the succeeding years, up to and including 1890—during which time he devoted much thought and energy to the advancement of the Society, and in 1892 was its President and from 1894 to 1918 inclusive was a member of the Board of Directors. Early in the eighties he joined The Mississippi Valley Dental Association which at that time was one of the leading Dental Societies of the middle west, being active in its affairs. He was president in 1889.

For many years a member of the National Dental Association, you are familiar with his share in its development. Since its reorganization he was continuously a member of the House of Delegates.

As we review his activities in the Cincinnati Dental Society it is difficult to express the real value of the man. Ambitious for its advancement, he gave generously of his time and talent to the furthering of its interests.

President of the Society in 1906-1907 he succeeded himself the following year. Largely thru his inspiration and influence nowhere do we find a local organization where harmony prevails and loyalty amongst the membership is greater than in his home society.

As we turn from the brief review of his life in practice and society work to contemplate his contribution to the literature and science of dentistry, it is with appreciation of his inspiration, patient endeavor and industry.

In 1888 he prepared his first paper. The Conservation of the Dental Pulp, which he read before the Mississippi Valley Association that year.

Quoting from his remarks at the dinner given in his honor in Cincinnati,

June 12th, 1917: "My first encouragement to undertake Research Work came from Dr. Atkinson of New York, who was present at the meeting of the Mississippi Valley Association, many years ago. I read on that occasion the first paper I ever had prepared. When I got thru reading I was nervous and excited. I wish the floor would open and let me drop thru. Dr. Atkinson whispered to me "My boy you *read well,* you keep *on* writing papers and some day you will write something worth while." That Dr. Atkinson's words were prophetic is evidenced by the results of Dr. Callahan's efforts.

To better equip himself for research work after locating in Cincinnati he took up the study of medicine in the Miami Medical College of that city and pursued his studies to within two months of graduation. He stated that having acquired the knowledge to aid in his work, not caring for a degree in Medicine he did not complete the course.

During this time, he, together with Drs. M. H. Fletcher and O. N. Heisie formed a study class, meeting in each others offices in the evenings and Saturday afternoons, which arrangement was continued for several years. Devoting his energies to the self imposed task in one problem in experimental research. In 1893 he gave one of his most valuable contributions to dentistry, in a paper read before the Ohio State Society, "Sulphuric Acid for Opening Root-canals." He established a method of rational treatment and preparation of canals in pulpless teeth.

In recognition of this valuable contribution to dental science, he was accorded honor both in this country and abroad.

Several years later, 1914.—A paper, "Rosin Solution in Root-canals," read before the Rehwinkle Dental Society, amplified by subsequent papers gave the results of extensive research extending over several years proved the value of this method, which is almost universally used today.

Thruout the years following the presentation of his first paper his discussions of dental problems were numerous and valuable. Recognized as an authority, he was eagerly sought as essayist and clinician by societies thruout the country. Not possible to present a list of his contributions at this time. It is planned that later his complete writings, compiled under the direction of the National Research Institute, will be available for the profession.

After years of study and research, on the establishing of the National Dental Research Institute, he brought to it a trained mind and hands and much valuable aid. February 23rd, 1916, he was appointed member of the Directing Medical Staff of the Cincinnati General Hospital. Director of Dental Department of the General Hospital and Tuberculosis Sanitarium and thru his influence more cordial relations between the Dental and Medical professions in Cincinnati was established. With increased facilities in the laboratories and clinics of the hospital, he devoted much of his time to research work and became so deeply engrossed that he gave little thought to his individual interests, rather hoping that he might solve the problems that so interested him while it was yet time. He was for many years an active member of the Cincinnati Research Society. Last year he realized his desires in seeing the Cincinnati Dental Research and Study Club established, in which he was the leading spirit and director of research study.

In recognition of the scientific contributions which he so freely gave to the dental profession, in May, 1917, the New York Dental Society conferred on

him the Jarvie Fellowship Medal, one of the highest honors in dentistry in America.

The professional life of John Ross Callahan was a success. Rich in attainment, rich in the respect and appreciation of a noble profession, rich in the loyalty and love of his friends and colleagues. After forty-one years of service his activities have ceased and this quiet, unassuming man has passed to his reward.

AN ESTIMATE OF HIS PERSONALITY.

By Thomas P. Hinman, D.D.S., Atlanta, Ga.

(Read before the National Dental Association at Its Twenty-second Annual Session, Chicago, Ill., August 5-9, 1918.)

IT IS given to few men to be so greatly beloved as was our departed friend, John Callahan. His friends knew him as "Honest John." No greater tribute could be paid a man than that of honesty—honest first with himself, then with the world. As the old Polonius said to Laertes, his son,

> "This, above all, to thine own self be true
> And it must follow as the night to day
> Thou canst not then be false to any man."

There was never a man truer to his friends or more generous to his enemies. In all my fellowship with him, I never heard him speak unkindly of anyone. He always saw the good in everyone and it always overshadowed the fault.

I well remember the last time he was in Atlanta. He brought me a set of slides of root end dissections which he had made for me. Handing them to me with a smile on his face, he said, "Tom, there are only two sets of the slides in the world and one of them is yours." This is a small illustration of his constant thought for the comfort and happiness of others. His greatest joy was to give of himself and his precious time to bring pleasure to his friends, never counting the cost.

He was not a rich man, as the world counts riches but in noble qualities, truth, honesty and charity, his wealth had no bounds. Truly he laid up for himself riches that cannot fade away; treasures that "neither moth nor rust corrupteth."

John Callahan was a searcher after truth not for his own benefit but for the good of humanity. I regret to think that his useful life was taken sooner than seemed fitting because of his incessant labors on research problems, labors which indeed have brought most gratifying results in the enlightenment of one of our most serious problems. If he had been content to use his knowledge for personal gain, he could have lived in ease and comfort. But no! His desire was to work and give.

His chief charm was his simplicity. Never given to pedantry, he conveyed his thoughts so simply that "the wayfaring man, tho a fool, could not err therein." Loyal to his belief, but never obtrusive, his opinions were respected far beyond the boundaries of his personal following.

It was ever his delight to get a few friends together after a dental meeting

and have a love feast of fellowship. It was my privilege, on more than one occasion, to be one of the boys sitting at the feet of the Master while he poured out beautiful thoughts and we worshipped at his shrine.

Longfellow beautifully expresses my feelings toward John Callahan in the following verses:

"I have you fast in my fortress,
And will not let you depart
But put you down in the dungeon,
In the round tower of my heart.

And there will I keep you forever,
Ay, forever and a day
'Till the world shall crumble to ruin,
And moulder in dust away."

We have lost a great man; the country a great citizen; dentistry, a sterling leader. He was truly "our kind of man" and truly does James Whitcomb Riley describe him in these lines:

OUR KIND OF MAN.

The kind of man for you and me!
He faces the world unflinchingly,
And smites, as long as the wrong resists,
With a knuckled faith and force like fists:
He lives the life he is preaching of,
And loves where most is the need of love;
His voice is clear to the deaf man's ears,
And his face sublime thru the blind man's tears:
The light shines out where the clouds were dim,
And the widow's prayer goes up for him;
The latch is clicked at the hovel door,
And the sick man sees the sun once more,
And out o'er the barren fields he sees
Springing blossoms and waving trees,
Feeling, as only the dying may,
That God's own servant has come that way,
Smoothing the path as it still winds on
Thru the golden gate where his loved have gone.

The kind of a man for me and you.
However little of worth we do
He credits full, and abides in trust
That time will teach us how more is just.
He walks abroad, and he meets all kinds
Of querulous and uneasy minds,
And, sympathizing, he shares the pain
Of the doubts that rack us, heart and brain;
And, knowing this, as we grasp his hand,
We are surely coming to understand.
He looks on sin with pitying eyes—
E'en as the Lord, since Paradise,—
Else, should we read, Tho our sins should glow
As scarlet they shall be white as snow?
And feeling still, with a grief half glad,
That the bad are as good as the good are bad,
He strikes straight out for the Right—and he
Is the kind of a man for you and me.

A REVIEW OF THE LIFE WORK OF J. R. CALLAHAN, BEING ESPECIALLY A DIGEST OF HIS CONTRIBUTIONS TO THE PROGRESS OF THE SCIENCE OF CORRECT ROOT-CANAL TECHNIC.

By Rodrigues Ottolengui, D.D.S., New York City.

(Read before the National Dental Association at Its Twenty-second Annual Session, Chicago, Ill., August 5-9, 1918.)

I FEEL much honored in having been selected to make a review of contributions to dental science and progress made by our deceased and much revered confrere, J. R. Callahan. At the same time I am much embarrassed too, keenly realizing my inability to do the man or the subject justice. However, as I have been limited as to time, I will pass over all further preliminary remarks.

Of the man himself I must say this. I do not know, as I write, just what those

that precede me on the program will have to say, but I do know this that nothing that they will say can overstate the lovable character of the man, the value of his services to dentistry, nor the debt that we all owe him. Personally, I know that I could not find words that would adequately express my own feeling of indebtedness to him, nor my appreciation of him.

In reviewing the life work of J. R. Callahan, and then collecting and reading all his contributions to our literature, one is surprised to find how little, comparatively speaking he actually published. It seems remarkable that so few papers could have made so great an impress upon our profession. The explanation, however, is to be found in the fact that he was ever at the beck and call of his confreres and probably delivered ten or twenty times as many lectures as are recorded in print.

Undoubtedly the chief recollection that we will all have of Callahan will be in connection with his lifelong efforts to improve our root-canal technic, and in reviewing this work it will be convenient to do so under three distinct heads:

First, the cleansing and enlarging of root-canals.

Second, the safeguarding of infected roots.

Third, the filling of root-canals.

Dr. Callahan, of course, wrote on subjects other than root-canal work. A complete list of his contributions will be found in an obituary notice which was published in Dental Items of Interest.

Aside from those of his papers which directly deal with the subject of root-canal work, there is but one to which I wish to draw especial attention. When the modern views on root-canal technic are expounded, the apostles of the new doctrines are constantly met with the cry, "Patients will not pay!" The economic aspect of the question then is important, and I would have you hear the voice of Callahan on this phase of the question. I offer you a few quotations from a paper entitled "Fees" which appeared in the Dental Summary, December, 1910.

"A man who has no self-respect will have little respect for others. A man who has no respect for others cannot succeed in professional life."

"A self-respecting dentist will never admit that his services are not worth at least as much as those of his neighbor dentist."

"He will not permit himself to become associated with a church unless he is a pious man."

"He will not preach prohibition, then step into the laboratory and take a drink all alone."

"To be known as a cheap dentist is fatal. If by word or action you have given your clientele to understand that you are as cheap as anybody, you at that moment forfeit the right to good fees, for by good fees we mean fees that are a little higher than those of your confreres. On suitable occasion, state to the patient, as modestly as possible that it is your desire and effort at all times to charge more than other dentists in your community."

"The patient will always come back at you with the remark that you must think your services better than those of other dentists. A quick rejoinder to the effect that the patient will have to decide that question, will place you squarely on your merit and there should be no argument about it. You have declared to the community your platform and you must make your services measure up to the standard of your declaration."

My friends, let us analyze and digest these words of wisdom for a moment. I present to your mind's eye two pictures.

A dentist opens an office in a given city, town, or locality. He lets it be known at once that he will work for low fees; fees lower than those already established. What is the result? In his eagerness to get business, even tho he take it from another man, he offers to undersell. This, at once, creates competition, engenders personal antagonism, but worse than all forces the least successful men in that locality to lower prices; to meet the cut rate. This in turn lowers the value of dental service in the estimation of patients, and ultimately makes it difficult for the cut rate man himself to rise above the level of the cheap dentist, and this means cheap dentistry. It is in such environment that correct root-canal technic becomes prohibitive. The method is purely commercial.

Now, the second picture. Another man arrives in that same community. At once he spreads the news that his charges must be higher than those of his competitors; that good services cannot be rendered by him except for good fees. This causes at first no antagonism on the part of the previous resident practitioners. The high priced man apparently is not a competitor to be feared. But it attracts the attention of the thinking patient, of the better class in the community, of the most desirable among whom to establish a clientele. Soon the previous practitioners find that higher prices do injure their business; that they are losing their best patients. Why? Because the other man is delivering a better service. The patient who has had several plates that do not stay up, obtains plates with which he can eat in comfort. The man who had his front tooth filled annually, obtains a filling that stays in. The woman whose tooth had been abscessed and discharging for two years, has the discharge stopped either with correct treatment, or with the forceps. Such a man in such a community, forces his competitors, not to charge lower fees to meet the competition, but to deliver better service. In time, fees go up. The community appreciates dental service. Thus we note the difference between commercial and professional competition. The one hurts everyone; the other benefits everyone.

Speaking directly upon the subject of root-canal work, Callahan says that root-canal work is the most neglected part of dental practice, and he continues:

"The principal reason for this neglect is that a large majority of the dentists of this country charge little or nothing for this most scientific and exacting service which they render."

"When a dentist tells me that he charges almost nothing for this kind of treatment, something whispers to me, and the patient hears the same kind of whisper, that his services in this direction are so poor that it hurts his conscience to even think of asking a fee. People do not want you to work for nothing; they are always suspicious of bargains."

The Cleansing and Enlarging of Root-Canals.

Let us consider now the main topic, beginning with the cleansing and enlarging of root-canals. It was Callahan who first suggested the use of sulphuric acid as an aid in this, and in latter years he came to be widely known as "Sulphuric Acid Callahan." A few quotations from his first published communication on this method will be of advantage here, thus correctly stating his position, and I have no doubt but that very few present have ever read this first paper. Indeed, as familiar as I supposed I was with this technic, there is one phase of it which was entirely new to me when I came to

actually read Callahan's own language. (Dental Cosmos, April, 1894, pages 329-32)

Speaking of root-canals that cannot be opened with the Gates-Glidden drill he says:

"It has been about four years since I began to open this difficult class of canals by using a twenty to fifty per cent. solution of sulphuric acid and the Donaldson root-canal cleanser. To illustrate the method, let us suppose we have a superior molar, from which the pulp tissue has been removed. The palatal root being large, can be prepared by any method you may choose; but let us say the canals in the buccal roots cannot be found. We would then place a pledget of cotton saturated with the acid solution in that portion of the cavity near the buccal roots, and seal it in the cavity for twenty-four or forty-eight hours; then upon the removal of the stopping, wash out the cavity with a dash of water in the syringe. Upon drying the cavity you will find it white and clean, with two dark spots in the vicinity of the buccal roots showing where the canals can be found."

This method of disclosing the apertures of obscure canals, old as it is, is new to the writer, and may be new to others. Of recent years the staining of the orifices with iodin has been advocated.

Coming now to the actual cleansing of the canals, Dr. Callahan proceeds as follows:

"Now we try to enter the canal with the nerve bristle; we find no opening. To make sure we are not being deceived by a constriction, we take a bud drill and follow these stains a short distance; if we find no opening, or a very minute opening too small for the bristle, we feel justified in saying that they need further treatment. But, if with our exploring instrument we find a canal, we will carry the acid to the canal by dipping the instrument in the solution, or by means of the pliers, or better still, the latest pattern of Dunn syringe made of glass and rubber with a gold or platinum point. Place a drop of the agent in the chamber and with a No. 5 Donaldson canal cleanser, pump the acid into the canal. The acid will soften the walls of the canal sufficiently to allow the broach to cut its way into the root; the acid will also thoroly sterilize the canal and everything in it. No germs nor spores can live in the presence of H_2SO_4 in the strength mentioned. The broach may scarcely enter the canal at first, but if you are persistent it will be but a few minutes till the instrument will go quite a distance into the canal, until you reach the end of the root where a much stronger resistance will be met with."

"The thickened cementum at this point seeming to offer a greater resistance to the agents used in the canal, can be enlarged by using larger broaches, or, if the root is straight, the Gates-Glidden drill will follow the canal just made. It is more than likely this apical foramen has not been opened yet; this can be accomplished, if desired, by drilling or by placing a small thread of cotton saturated with the acid solution in the end of the root and leaving it there over night, and then using the acid and broach at the next sitting."

"After one or two trials you can readily see how crooked or obstructed canals may be opened in a few minutes, and the canal will be in condition for immediate root filling. It must be borne in mind that the rubber-dam should always be in place before the operation is begun. The adjoining teeth may be protected by placing the rubber-dam on none but the tooth being operated upon."

The last statement in the quotation

from Dr. Callahan brings to mind a technic perhaps worth mentioning. He speaks of isolating a single tooth with the rubber-dam. A similiar recommendation has been made in connection with the modern use of ionization, the adjacent teeth being thus insulated from the current. It is, however, often extremely awkward to work with but a single tooth projecting thru the rubber. The desired end may be accomplished as follows: Place the dam in the usual manner, four or more teeth protruding thru the rubber. The seat of operation is thus comfortably disclosed, and all preliminary work may be readily completed. Just prior to using ionization, (or any agent which we desire to confine to the one tooth alone, as for example the new treatment recommended by Dr. Percy Howe) a second and smaller piece of dam may be slipped over the one tooth to be treated, and kept in place during treatment only, being readily removed before closing the cavity for the day. This method, in connection with ionization, affords the best insulation, as we have the tooth to be treated encased in two layers of rubber, thus walling off metallic fillings in adjoining teeth, as well as covering the gum septum.

In the quotation from Dr. Callahan's paper I am sure many will be surprised to note that the use of sodium bicarbonate is not mentioned in the article. It does occur, but only in the following lines:

"We can have the action of the acid under perfect control. I always keep a saturated solution of bicarbonate of soda on my case so that I may stop the action of the acid at any moment."

Here it is to be observed that the bicarbonate of soda is mentioned only as a safeguard against injury to the tissues. But at a later period Dr. Callahan advised that after working the sulphuric acid into the canal, it should be followed by the sodium bicarbonate solution. Many have used this without a full comprehension of the purpose. It is not to be used in minute dosage, or by slow dropping; rather the sodium bicarbonate should be forcefully injected into the canal, thus producing a rapid and powerful reaction, the explosive character of which evacuates the canal of its contents. Of this explosive nature of the combination of the acid with the soda, Dr. Callahan took especial advantage in another technic, described more recently.

In a paper read before the Second District Dental Society of New York, (Dental Items of Interest, Aug. 19) Dr. Callahan reviews his own sulphuric acid technic, giving us his method after twenty-five years' experience therewith. It was in this paper that he made a new recommendation, as will be seen, combining the sulphuric acid and bicarbonate of soda method with, and as an adjunct to, the use of sodium and potassium. I quote as follows:

Sulphuric Acid Method of Cleansing Canals.

"Twenty years ago sulphuric acid solution and soda bicarbonate solution came into use.

"The sulphuric acid is used for the purpose of softening the surface of the pulp canal walls to permit the passage of the barbed or roughened broaches to and fro thru the canal, enlarging the canal by breaking loose the softened dentin. Soda bicarbonate solution is thereupon injected into the canal that the broken down dentin and other disorganized substances may be removed from the canal by effervescence caused by the escape of carbonic acid gas that is the product of the neutralizing action of the soda bicarb upon the sulphuric acid.

"This reaction leaves the canal in a

state of surgical cleanliness. This cannot, to my knowledge, be said of any other method or agent.

"A fifty per cent (by volume) solution of sulphuric acid will soften cotton on the carrying instrument. A weak acid solution gives a correspondingly weak reaction in the presence of the soda solution.

"The strength of the acid solution should be not less than twenty per cent and not above forty per cent for root-canal work. In my own practice thirty per cent to forty per cent aqueous solution or commercial sulphuric acid by volume is the standard."

Soda bicarbonate should be a saturated solution.

METHOD OF APPLYING ACID IN CANALS.

"Sulphuric acid causes delicate steel instruments to become brittle and to break on small provocation, leaving small pieces of steel buried within the canal. This unpleasant accident is, as a rule, due to the manner of manipulating the broach.

"For very fine canals the barbs should be partially or wholly removed from the broach or a fine broach can be made from gauge twenty to twenty-five piano wire. These broaches should be cut to proper lengths and placed in a rigid holder or handle that will hold the broach in a direct line with the line of force. Either pressure or traction may be applied to the delicate steel point. For the heavier work, digging or enlarging should be done with larger and stronger points, made of roughened steel. A better and safer instrument may be made by taking the largest tantalum silicate plugger points, No. 104, or 5 S. S. W., bend to straight line, remove from the handle, file or grind to proper shape, and place in the strong right-angle broach holder made of ivory. This makes a most effective root-canal excavator.

"The metal is not acted upon or altered in any way by acids. This manner of enlarging or excavating the canal to a large extent at least eliminates the probability of making a false track or pocket within the canal, and does away with the necessity of using a drill, at least, until the canal is large enough to make drilling a safe procedure.

USE OF SODIUM AND POTASSIUM.

"If the finer canals contain fairly well organized pulp tissue that the broach fails to engage, sodium-potassium should be applied. After the pulp or other organic tissue has been converted into a soapy substance, the removal of this soap from the canal becomes a necessity; some of it may be removed with a stream of water; only a small portion, however. Swabbing with cotton on a broach does but little better. If the root-canals of an extracted tooth be opened and thoroly treated with sodium-potassium, the canals then washed out with water as would be done if the tooth were in the mouth, and if you then dry the tooth and crack open the roots, in the apical third of the root-canal a dark, rather dense, soapy mass will be found packed within the fine canal. If the tooth fragments be kept dry for a day or so the dentin will show a greenish-yellow color—not a very pronounced discoloration, but sufficient to show the presence of a coloring matter. All of this soapy mass will be thoroly removed from the canal, if sulphuric acid be pumped into the canal in sufficient quantities to overcome the alkali, and having been worked to the end of the canal with a broach, then the root canal should be flooded with a saturated solution of soda bicarbonate. The reaction will at once remove practically all

foreign substance from the canal. If the tooth then be dried and the roots cracked open, the canals show white and clean as marble.

"With the tantulum root excavator and sulphuric acid, the root-canal may be enlarged more rapidly and with greater freedom from unpleasant and sometimes dangerous conditions. The acid destroys and breaks down disorganized organic tissue, the soda solution removing the debris without forcing the disorganized substance thru an open foramen, as many dentists seem to fear."

The new use of the sulphuric acid and soda bicarbonate method previously alluded to, is that described above where Dr. Callahan advocates its utilization for removing the dark, usually greenish soapy contents of the canal often present after the use of sodium and potassium. Indeed this part of Dr. Callahan's work is especially reviewed here to emphasize the fact, seemingly not comprehended by all, that the mere utilization of sodium and potassium for entering and enlarging canals, does not suffice. As Dr. Callahan points out the canals are not yet cleansed. It is also true, as he says, that syringing as a rule does not thoroly cleanse the canal. His statement that "Swabbing with cotton on a broach does but little better" does not quite cover the facts.

A satisfactory technic in ninety per cent of cases is as follows: The finest Young aseptic broaches, should be used. These permit the wrapping on the twisted points of the veriest shred of cotton, which nevertheless suffices for swabbing out of the canals. Broaches used in this particular technic, and wrapped in this manner with the fingers, do not require to be sterilized by boiling. The writer is prepared to prove this if the claim be questioned, but time does not permit. The wrapped broach is dipped in a solution of bichloride of mercury in the proportion of 1 to 500, in Marchand's peroxide of hydrogen. The canal is swabbed out with this, and then the cotton wiped off on a Johnson and Johnson sterile napkin. Usually the first piece will lie on the napkin as a dark or green streak. The broach is again wrapped, dipped in the peroxide, bichloride combination and the canal again swabbed. This is continued until several such swabs lie on the napkin perfectly white and clean, whereupon it may be concluded that the canal has been fully cleansed.

But there are canals so fine that a broach carrying cotton, cannot be used for such swabbing, as the cotton cannot be forced into the canal. It is here that Dr. Callahan's proposed new technic has proven most valuable. If the canal be treated with the sulphuric acid, and then the saturate solution of sodium bicarbonate be used, and this treatment repeated two or three times, the canal will be thoroly cleansed.

In passing it may be well to mention a modification of this technic recommended at this same meeting by Professor Prinz who discussed Dr. Callahan's paper. Dr. Prinz advised the use of aqua regia in place of sulphuric acid. Dr. Callahan warns us that sulphuric acid corodes steel instruments and advises the use of tantulum where possible. Some of the manufacturers are now providing broaches which are said to be resistant of sulphuric acid. Professor Prinz pointed out that aqua regia will serve every purpose of the sulphuric acid, and yet does not injure steel. Whether aqua regia will be as energetic in enlarging root-canals as sulphuric acid, I am not prepared to decide, but for the purpose of cleansing a canal which has been treated with sodium and potassium, I can testify that it is thoroly

efficacious, and perhaps more so than sulphuric acid, the reaction from the addition of the bicarbonate of soda being greater; possibly because we use the aqua regia in full strength, which can be done safely because it is neutralized immediately.

For best results, the aqua regia should be freshly mixed, by adding hydrochloric acid to nitric acid just before using.

Before passing this subject it might be well to state that the writer cannot conscientiously recommend the so-called sulphuric acid pastes on the market. Whatever the base used for producing this pasty solution may be, it appears to be an insoluble earthy substance and is deposited in the canal, at times proving difficult to remove. The clear acid brings the best results.

The Safeguarding of Infected Roots.

We come now to the second phase of this subject, "The Safeguarding of Infected Roots." In Callahan's original paper, from which we have already quoted we find the following statement:

"* * * * the acid will also thoroly sterilize the canal and everything in it. No germ or spore can live in the presence of H_2SO_4 in the strength mentioned."

"* * * * the acid will also sterilize the canal and everything in it." Who can doubt that statement? Yet Callahan himself discovered that something more is often needed; something more than the mere sterilization of the "canal and everything in it." He concluded that in teeth suffering from severe infections the dentin itself becomes infected and unless that can be sterilized it must be rendered safe; safe that is to be retained as a part of the human body all parts of which we now know may become diseased from a minute focus of primary infection. It is for the above reason that I allude to Callahan's method as one that safeguards an infected root. I allude to his proposal that the dentinal tubuli shall be filled with a solution of rosin. This communication would be incomplete if I omitted Callahan's formula for his rosin solution, for which reason I quote the following: (Dental Items of Interest, August 1915.)

"The rosin that is best adapted to dental uses that I have been able to find is that prepared by Bernardel for the use of the violinist. It is a French preparation, very near the color of dentin. The formula, as given below, makes a very thin solution. It required a long time for me to realize the advantage in the use of a thin solution. A thick mixture will not penetrate the tubules, nor does it give up enough chloroform to dissolve the gutta-percha:

R Rosin .....gr. xll
Chloroform 3iij
M. Fiat Sol."

The attention of the members of our profession has been so constantly called to the subject of root-canal treatment in the recent past that probably the majority who think of Callahan's rosin technic at all think of it solely in relation to root-canal work, yet he recommended it for a much more important role; no less than the salvation of pulps alive.

Pulp Capping.

On the subject of pulp capping I quote the following:

"It is thru these dentinal fibrils that nervous stimuli are transmitted to the pulp. Following the teachings of Miller and Black in the study of carious dentin, we note among other interesting things that caries progress along the lines of the dentinal tubuli; that the form of the disintegrated dentin is that of a cone with the apex toward the pulp chamber, and that the dentin is decalci-

fied in advance of the penetration of the microorganisms.

"It is not likely that in the preparation of cavities we always remove the apex of the affected dentin. In deep-seated cavities is this advisable? In spite of the application of strong antiseptic agents, recurrent decay may develop and toxins finally reach the pulp.

Advantages of Rosin.

"If the remaining traces of thin layers of decayed dentin can be thoroly dehydrated, the application of rosin solution may be of great service.

"First, rosin being more or less a non-conductor, it reduces the shock of thermal changes, thereby lessening the tendency to secondary growths or deposits within the pulp chamber that are so noticeable under large metallic fillings, especially under large gold inlays.

"We are taught that the decalcified dentin that is to be found just in advance of the microorganisms in carious dentin furnishes food for the invading germs. If the remaining decalcified dentin be saturated with rosin, I imagine the cost of living in that region will become prohibitive. However, if the rosin solution reaches the farthest boundaries of the decalcified dentin thru the infected area, then the microorganisms within the tubuli will have been engulfed within the rosin solution, and unless the bacteria are able to liquify the rosin, they will be forever inhibited from further activity, be they aerobic or anaerobic, in active or spore form. I need only mention the antiseptic properties of the chloroform.

"This, you will admit, would be a very desirable condition in which to have a layer of decayed or decalcified dentin over the pulp, where the removal of the layer of decay would mean the exposure of the pulp.

"The most satisfactory results that I have had in capping pulps has been to flow a rosin solution over the exposure, evaporating the chloroform with warm air, then to cause a very thin cement to flow over the floor of the cavity and the thin coat of rosin and allow it to harden, being very careful to avoid pressure of any kind on the cement until quite hard.

"This practice has been confined to quite small and recent exposures. Not the least satisfactory use of the rosin solution is after more or less thoro drying of the cavity, an application of the rosin is made prior to the insertion of gutta-percha filling, either as a temporary, or permanent filling.

"On the removal of a temporary stopping of this nature, that has been in place a week or a month, the decayed dentin, which for any reason may have been left in the cavity, will be found noticeably tough and hard and dry, due to the presence of the rosin, and the sensibility of the dentin will be materially less, showing that the dentin has been free from the irritating effects of acids, or, in other words, the fibrils have been in a state of comparative rest. And after all is said, the chief function of the surgeon is to remove the irritant and place the affected region at rest, to the end that Nature may perform a cure."

Treatment of Root-Canals.

Coming now to the canal proper we must admit that it is impossible to determine absolutely whether the infection be confined to the canal proper and the surface thereof, or whether the dentin has been penetrated and if so, to what extent.

On the subject of root infection Callahan had this to say:

"We have the testimony of several investigators to the effect that it is possible to sterilize the root-canal proper, but it is an impossibility to sterilize the

infected dentin of a tooth while it remains in the mouth.

"The microscope and the culture media have shown us conclusively that we have been, and are now, leaving enormous numbers of microorganisms within the body with a more or less available route open to the circulatory system where they may reach any part of the body, carrying destruction to those organs or parts that may offer the most attractive lodging place.

"A most significant fact must be borne in mind in regard to the devitalized dentin. We have no blood current to assist in the struggle. The dentin has absolutely no power even to assist in repair. No granulation nor scar tissue—nothing but an inert tubular mass infected by millions of toxin producing microorganisms. We must make of this infected tubular mass an inert, harmless and stable body, including the effective closing of the numerous foramina, to the end that Nature may be able to develop the root mass in a healthy and vigorous peridental membrane that the tooth may serve its several useful purposes for a number of years."

After twenty years experience, Callahan concluded that the sulphuric acid alone, even tho it does "sterilize the canal and everything in it," does not safeguard the root that is seriously infected. Recognizing that the dentin itself is penetrated, but likewise realizing that no man may determine the exact depth of such penetration, he concluded that the mere mechanical removal of this infected tissue by scraping of the canal walls would likewise often prove ineffectual, especially as in tortuous canals this scraping is a hazardous procedure.

But he suggested, and to a great extent believed that if rosin in solution could be forced into this infected canal wall, the root could be safeguarded. To use his own words, already once quoted:

"If the rosin solution reaches the farthest boundaries of the decalcified dentin thru the infected area, then the microorganisms within the tubuli will have been engulfed within the rosin solution, and unless the bacteria are able to liquify the rosin, they will forever be inhibited from further activity, be they aerobic or anaerobic, in active or spore form."

Dr. Weston A. Price has repeatedly told dental societies during recent months that "infected dentin cannot be sterilized in the laboratory by any means available in the mouth."

If this be true, and if it likewise be true, as Callahan claimed, that the further growth and deleterious action of bacteria will be inhibited "if the rosin solution reaches the farthest boundaries of the decalcified dentin thru the infected area" have we not at hand the possible solution of our problem? Must we not either further perfect Callahan's technic, so that his rosin will search out the infected tissue and enmesh bacteria to the farthest boundaries, or, failing this, must we not seek until we find another agent that will in some similar fashion safeguard infected roots?

The Filling of Root-Canals.

Coming now to the third phase of our subject, "The Filling of Root-Canals," Callahan described his technic as follows: (Dental Intems of Interest, August, 1915.)

Rosin and Gutta-Percha Root Fillings.

"The technic of the rosin-gutta-percha root filling is simple, easy, quick, and sure to seal all tubuli and foramina that are open. Before proceeding with the filling of the root-canal, all instruments, cotton, paper points, gutta-percha points, should be placed in the steam chest, superheated steam being the most effective sterilizing agent. After steaming the proper length of time, the steam

is shut off from the chest. This soon dries the instruments, points, cotton and broaches. The gutta-percha and paper points after cooling in the basket have lost none of their desirable properties.

"I have said that a root-canal should be of the general shape of the fine paper root-canal driers as furnished us by the dealers. In addition to this general form, have the mouth of each canal a decided saucer shape. This will facilitate the placing of agents or instruments to or near the apical foramen.

Drying Canal.

"The first step, then is the complete dehydration of the dentin, using acetone, as advised by Dr. Prinz, as the dehydrating agent. After flooding the canal with acetone, use the paper points liberally until the canal is entirely free of moisture. Follow this with warm air. Then hold a warm wire in the canal for a minute or two, being careful that the wire is not hot enough to scar any part of the canal.

"Right here is where many root-canal operations fail. The canals and tubuli must be as dry as it is possible to make them, bearing in mind that it is possible to do damage by overheating the root.

Introducing Rosin.

"Now flood the dry root-canal with the thin rosin solution, pumping it in with a wisp of cotton on a broach. When the canal is full of the solution, pass a fine wire or broach to the end of the canal. Work out all of the air that may be trapped therein. This is of vital importance.

"After the canal has been flooded or pumped full of the rosin solution, dip the cotton and broach that is being used into or pick up on the cotton, bismuth oxide hydrate. Work this into the rosin that is already in the canal. This is not essential to the preservation of the filling, but makes a more distinct picture of the finer canal fillings when the x-ray is in use.

Inserting Gutta-Percha Cone.

"The canal point should be made of base plate gutta-percha. It should carry no drugs nor any additional element that will have a tendency to weaken or reduce the strength or rigidity of the cone, because we wish the gutta-percha to dissolve rather slowly at the periphery, while the attenuated center retains rigidity sufficiently to permit of being pushed along.

"Select a gutta-percha cone that will reach to or near the end of the canal, holding the cone with a fine foil carrier, and pass the cone carefully and surely about half-way into the canal, pumping the cone up and down in the canal, usually from forty to sixty times, and, as it dissolves in the chloroform, advancing the cone farther toward the apex.

"The pumping motion forces the rosin solution farther into every opening. The chloroform at the same time dissolves the periphery of the gutta-percha cone, which, becoming more and more attenuated, slips farther toward the apex, surrounding itself with a mixture of gutta-percha and rosin. The rosin seals the tubuli and at the same time causes the gutta-percha to stick tight to the canal walls and makes the gutta-percha more stable and proof against the action of body fluids or substances.

"If this does not leave the large end of the gutta-percha cone at or near the end of the canal, place a small cone alongside or on the first one, then, with cold steel plugger points that will go into the canals, gently pack the mass into the canal, using warm air to soften the protruding gutta-percha if necessary.

"This packing forces the semi-fluid (chloro-percha and rosin) into the unknown canals and pockets, and at the same time brings the surplus chloro-percha to the mouth of the canal, where

it may be taken up with absorbent rolls or cotton.

"In multi-rooted teeth, complete the filling of each individual canal before starting another.

"Rub the steel plugger points on paraffin cake to prevent the partially dissolved gutta-percha from adhering to the instrument. The pulp chamber is to be filled with one of the cements."

Modifications of Callahan's Technic.

I will now with some hesitation present to you a modification of Callahan's technic, which I should not make public were Dr. Callahan alive, feeling that it would be preferable to cooperate with him or else let him communicate the ideas and comment on them himself after further investigation; for after all what I have to suggest is but an extension of Callahan's work. But Callahan is dead and hence I believe the communication should be made at once that more than one mind may be at work, provided the suggestion meets with approval.

Callahan has told us that the success of the rosin method largely depends upon the depth to which the solution is forced into the tubuli of infected dentin. His method of thus forcing the rosin into the body of the dentin is to flood the canal with rosin and then pump a cone up and down from forty to sixty times.

In two conditions there are objections to this method. If the foraminal aperture be large, or even freely open, this constant pumping will force an undesirable quantity of the material beyond the apex. On the other hand, if the canal be most minute, admitting only the finest broaches, no cone of gutta-percha fine enough to even enter the canal will be resistant enough to act as a piston in this pumping motion.

The modification of the technic then is as follows: In canals having wide open foramina, the actual foramen would be closed first. Dr. Coolidge has suggested a good method of accomplishing this, by making measurements and forcing to the end just enough of a gutta-percha cone to close the orifice. (See Dental Items of Interest, July, 1918.) Another method is to introduce some rather thick chloro-percha forcing it gently towards the end. Follow this with a tiny part of a cone pressing it towards the end. Follow this with a tiny part of a cone, pressing it towards the apex. Immediately take and develop a radiograph. This will usually disclose the fact that the apex has already been reached. In canals of this character, indeed it is difficult not to overdo and protrude the mass beyond the apex. Occasionally the radiograph will show that the apex has not been closed, but the picture will be an aid in determining the degree of extra pressure that then may be exerted to force the mass quite to an end.

The foramen thus closed either by the Coolidge method or by the one herewith presented, the case should be dismissed for one or two days, depending upon the size of the foramen. This permits the material at the root end to harden.

The writer is quite well aware of the fact that this is not yet an adequate sealing of the root end. But at the second sitting we follow the Callahan technic. The rosin solution is introduced and the pumping with the gutta-percha cone is carried out. If this method can force rosin into the tubuli of the dentin, assuredly it will force rosin around and about any inadequate contacts that may exist between the root end filling and the walls of the canal at the apex. At the same time the plugging of the orifice will prevent the egress of too great quantities of the solution. Indeed, the fact that the apex is closed gives us confidence to use extra force in pumping the rosin solution into the dentin.

In further study of this idea, Dr. Van Woert and myself have tried to develop

a method by which a power syringe could be used to force the rosin into the tubuli, after closing the root end. Thus far we have not succeeded; but that fact need not deter others from experimenting along these lines. Either or both of us would be glad to cooperate with any one on this subject.

Filling Fine Canals.

Next we come to the minute canals, into which the pumping with a gutta-percha cone is impossible. Of course, if such canals could be enlarged first, then the method could be utilized. But thread-like canals may often be readily opened from occlusal end to foramen with little trouble, whereas their enlargement is often a hazardous, if not an impossible procedure. It is manifest that if these fine and tortuous canals may be filled and safeguarded as we find them when the radiograph first discloses the fact that we have reached the apex, such method would be more desirable than to risk the breaking of broaches or drills, or the creation of pockets in the canal walls, or the stopping of the canals with debris forced ahead of drills.

In these very fine canals the modification of Callahan's method is as follows: The rosin solution having been introduced, it is followed with a solution of chloro-percha which is pumped in with the canal instrument which had been used to clear the canal to its foramen. The forty or fifty pumping motions can be used here, utilizing the steel instrument rather than a gutta-percha point. In the true Callahan method the gutta-percha point slowly dissolving in the rosin solution supplies the chloro-percha. But in these very fine canals the chloro-percha element may be supplied by dipping the steel canal instrument into the chloro-percha every time it is introduced into the canal.

To those who may doubt the efficiency of this method the following experiment is suggested. Obtain a glass pipette with the tiniest tubular center. Heat to red heat in a Bunsen flame and then draw out producing the most attenuated glass "root canals." Introduce chloro-percha into these fine glass tubes in the manner outlined, charging the broach with the chloro-percha and using the pumping motion. You will note at once that the broach acts as a piston and forces the chloro-percha further and further towards the end of the canal, which is readily seen because of the transparency of the glass tube. If continued long enough the experimenter will likewise observe that the solution will pass out at the apex or foramen, as a globule, and that this globule of chloro-percha will increase in size constantly if the pumping is continued. This little experiment is so informing, and so easily done that all canal workers should try it, and thus acquire some knowledge of the action of our filling materials, and the degree of pressure needed to fill root-canals. This experiment likewise accentuates the advantage of closing foramina before doing any great amount of pumping of solutions.

Coming back to the root-canal technic, after the pumping with the "broach charged with chloro-percha has been carried to its full extent, fine gutta-percha rods, or wires, not cones, are to be introduced in small pieces and packed into the chloro-percha, piece by piece thus taking up the excess of chloroform and solidifying the root-canal mass. The pressure needed for this aids also in forcing the rosin into the tubuli.

Again, I say that I have had some hesitation in presenting these modifications of Callahan's technic. Nor would I do so but for the fact that in my very last visit with my dear friend, we fully discussed this matter and I had received his approval of these suggestions, to the extent that he had agreed to experiment with them and report later. Would that he had lived to do so.

THE SUPPORTING STRUCTURES AND VASCULARIZATION OF THE TEETH.

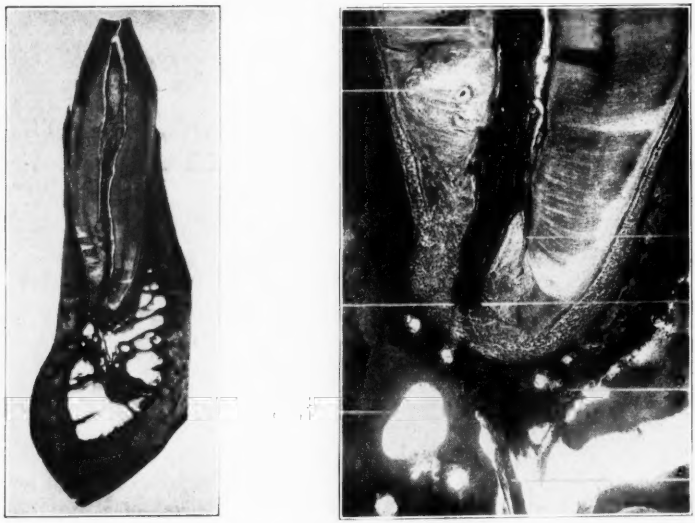
By John R. Callahan, D.D.S., Cincinnati, Ohio. (Deceased).
Assisted by Alphonse Lang.

Researches Conducted Under the Auspices of the Cincinnati General Hospital and the Research Institute of the National Dental Association.

EXPLANATORY NOTE TO THE PROFESSION.

THE sudden death of the late Dr. John R. Callahan, while his investigations were in progress but not quite ready for publication, precluded the possibility of that being done in the splendid form in which it would otherwise have been, could he have completed and supervised it. The products of his efforts were considered so important that his research materials, complete and incomplete, were transferred to the Research Institute of the National Dental Association at Cleveland, and his splendid assistant, Mr. Alphonse Lang, was engaged to complete the grinding and mounting of his specimens and to put them in permanent form for the use of the dental profession. The Trustees of the Institute provided means for making a permanent exhibit of this remarkable scientific material. Over one hundred of his specimens have been mounted and photographed and can be seen at any time. A large number of the original ground sections have been mounted as transparencies and are both beautiful and instructive. It was Dr. Callahan's wish to write up this material for report quite soon. Some of it had been presented informally by himself with lantern slides at the National meeting in New York in October, 1917, and before the Ohio State Dental Society in December, 1917. We have used as titles, where possible, the stenographer's report of his own statement regarding the subject. There is much more in these pictures than is suggested in the necessarily brief titles. His many friends thruout the world will be interested to know that the Ohio State Dental Society has appointed a committee to establish some form of a permanent memorial. A memorial hour was given to his memory and work at the meeting of the National Dental Association, Research Section, held in Chicago in August, 1918. Estimates of his personality, a review of his life work and his part in professional up-building were given at that time. These will be published in the Proceedings of the National Association. Prints from the negatives of Dr. Callahan's specimens can be purchased from the Research Institute, at cost. WESTON A. PRICE.

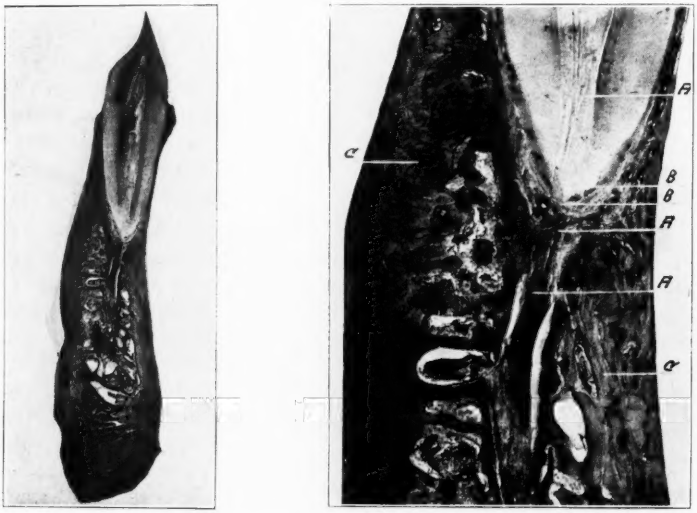
Figure 1.



"Ground section of mandible with incisor, stained with Borrell. Note the lines appearing to be vessels in the pulp. Note the peculiar nodular formation in the dentin at one side. The vessel from the inferior dental canal branching to supply both the pulp and peridental membrane."—J. R. C.

A. Inferior dental canal. B. Vessels. C. Nodular formation in dentin. D. Multiple foramina.

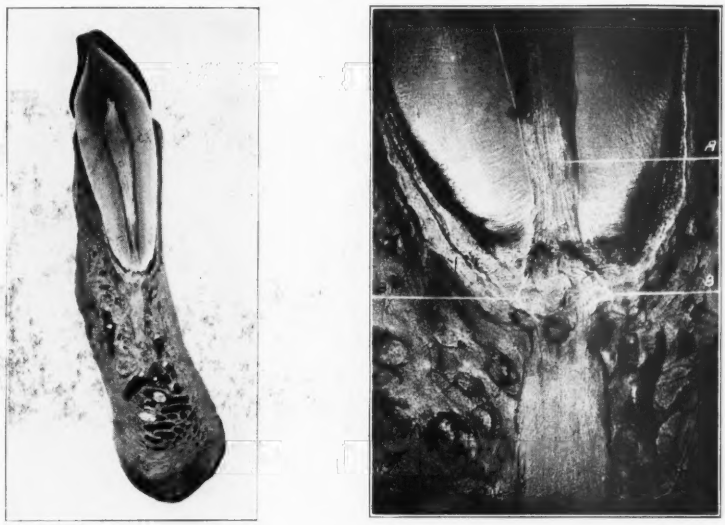
Figure 2.



"Ground section of mandible with incisor, stained with Borrell. Note the lines appearing to be vessels in the pulp. Some seem to be branching below the apex of the tooth toward the peridental membrane from the main supply which is extending from the inferior dental canal. Note also the solid structure of the jaw in this section and the little soft tissue present. It seems from this specimen and the fractures observed in the Dental Clinic of the General Hospital that healing occurs more quickly and with less danger of infection than in the molar region."—J. R. C.

A. Vessels. B. Multiple foramina. C. Dense bone.

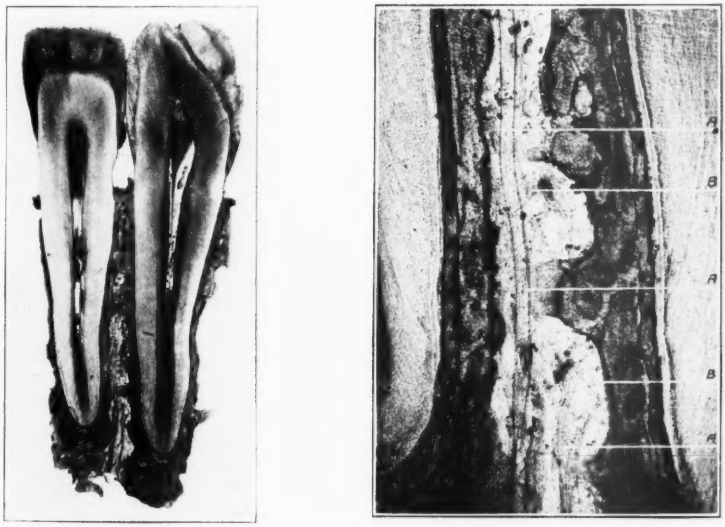
Figure 3.



"Ground section of mandible, cuspid region, unstained and clarified in creosote. Note the coagulated mass, apparently vessels of the pulp. There is also a crossing in the nerve tissue and blood supply before it goes up into the tooth. The point I am getting at is: What is going to happen in this region if you go thru with a broach and acid? We should understand these conditions in the root-canal work. If we travel in a strange country, we want to know where the dangers are."—J. R. C.

A. Vessels. B. Crossing of nerves and vessels.

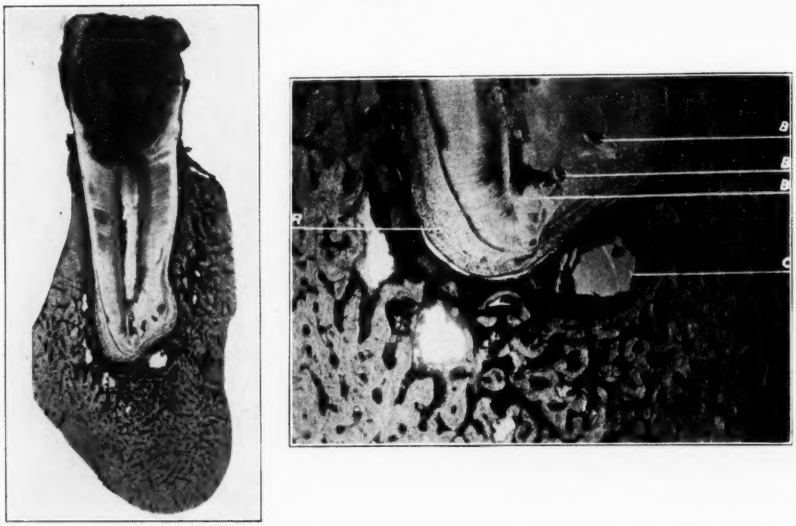
Figure 4.



"Ground section of mandible, incisors, stained with hematoxylin and Van Gieson B. This specimen was taken from a post mortem case in the General Hospital a few hours after death and I can claim that I got about the same results I would have gotten in living bodies. Note the vessels in pulps and in the bony process between the teeth."—J. R. C.

A. Vessels in bone septum. B. Fatty tissue.

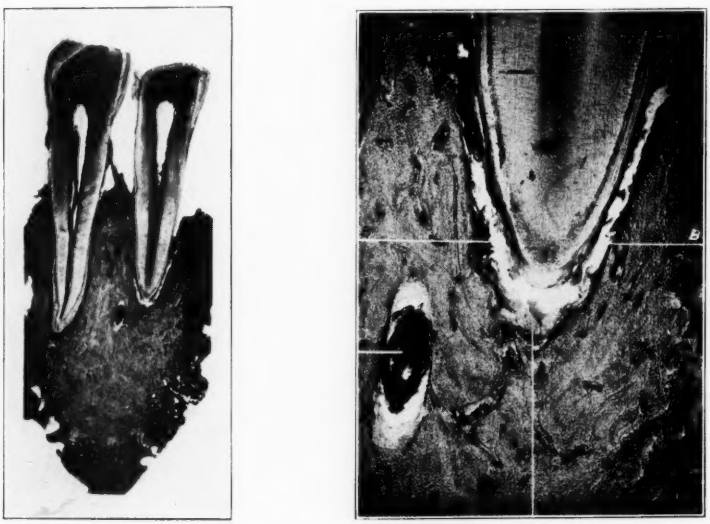
Figure 5.



"Ground section of mandible, molar, stained with hematoxylin and eosin. Note the inferior dental canal close to the roots. If you get sodium-potassium into that bone tissue, what would happen? If you get sulphuric acid into that bone tissue, what would happen?"—J. R. C.

A. Thickened cementum. B. Multiple foramina. C. Inferior dental canal.

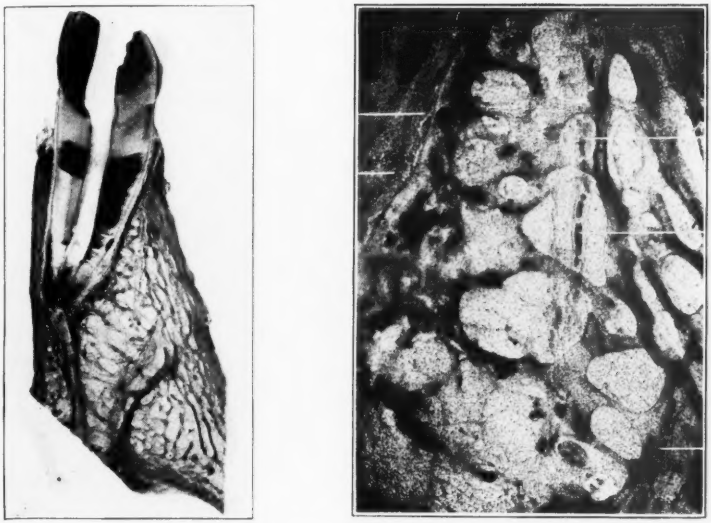
Figure 6.



"Mandible, longitudinal section, stained with Borrell. Note in some parts the perforation of the peridental membrane."—J. R. C.

A. Vessel. B. Bone absorption.

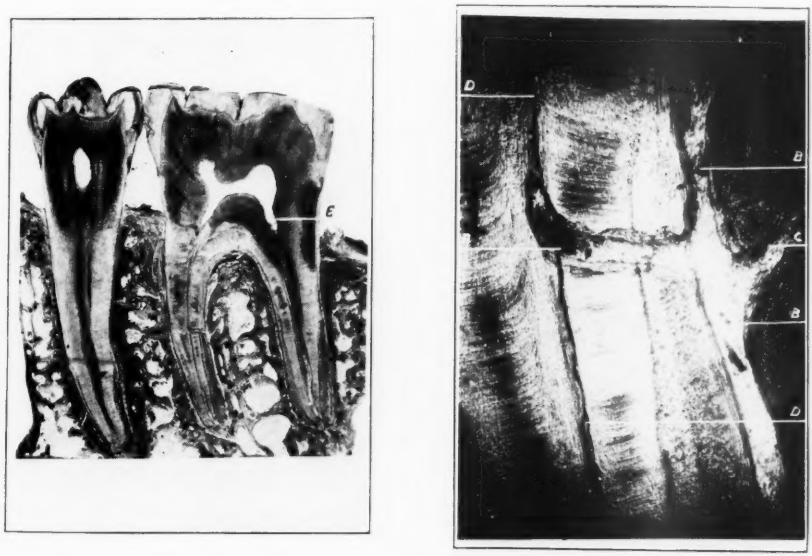
Figure 7.



"Ground section of upper maxilla with incisor, stained with Van Gieson B. Note the coagulated mass of a brownish color appearing to be blood vessels, some running in the pulp and some are distributed individually from the middle part of the bone to the peridental membrane."—J. R. C.

A. Vessels. B. Cementum.

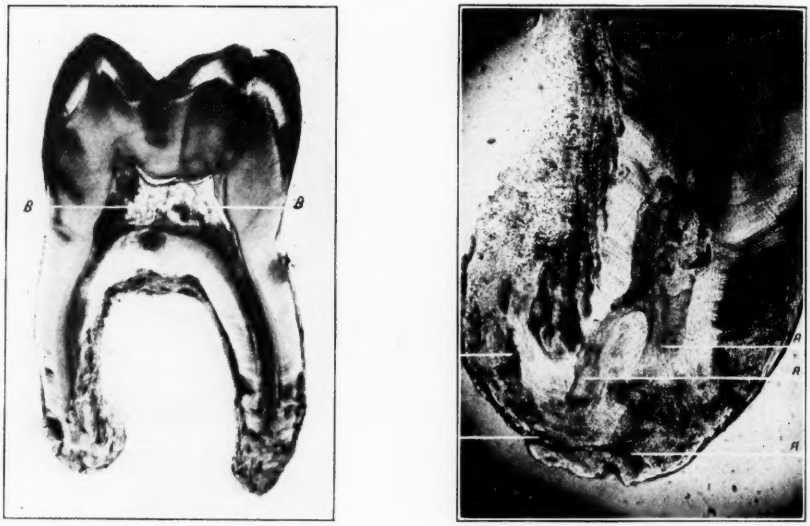
Figure 8.



"Section of mandible with bicuspid and molar, stained with Van Gieson A, a remarkable specimen. Note the canal on the posterior aspect of the anterior root of the first molar."—J. R. C.

A. Canal. B. Peridental membrane. C. Vessels. D. Anterior root-canal, very small compared with posterior root-canal. E. Narrow orifice of canal in distal root.

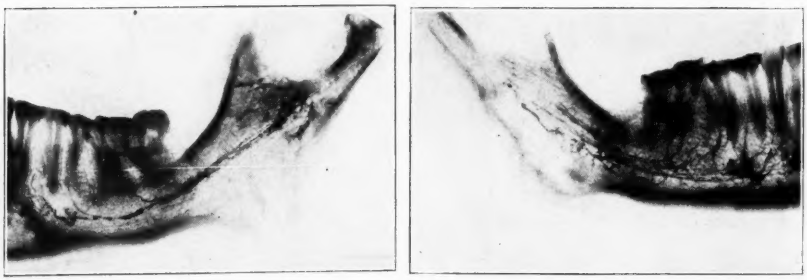
Figure 9.



"Ground section of lower molar, stained with Van Gieson B. Note the pulp stones and multiple foramina in one of the roots."—J. R. C.

A. Multiple foramina. B. Pulp stones.

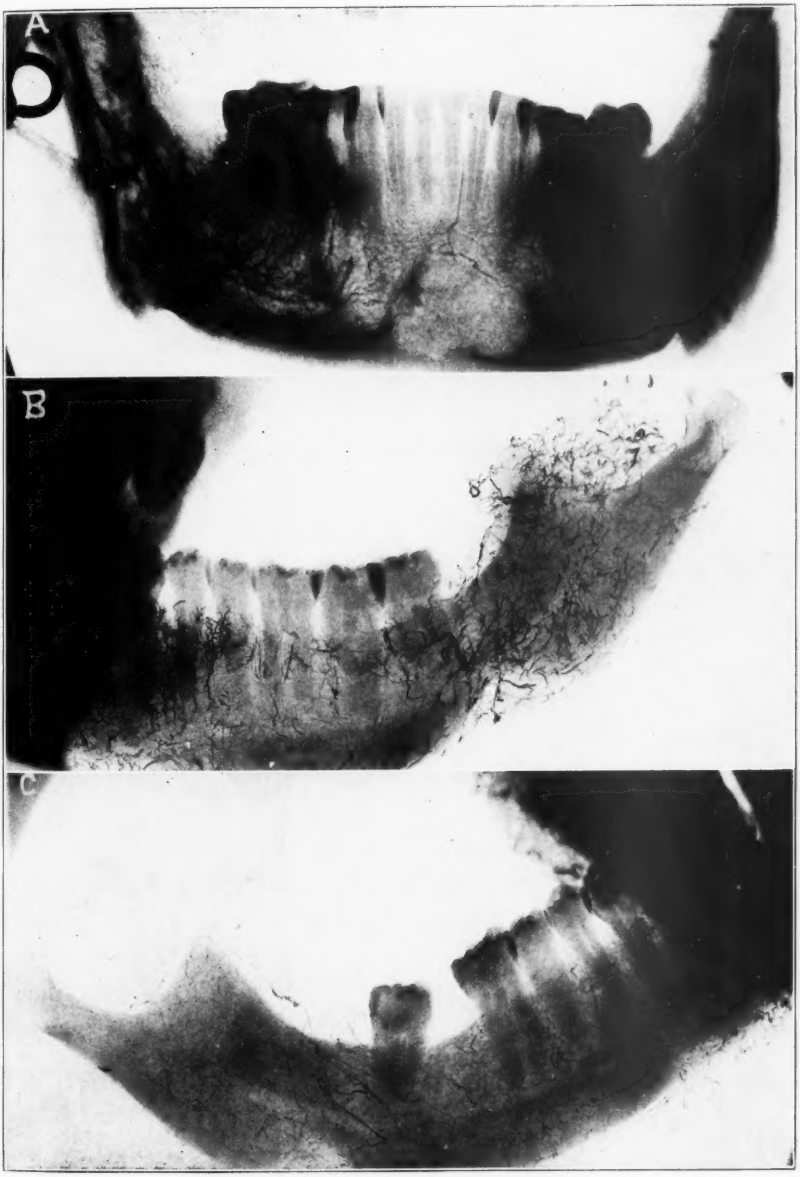
Figure 10.



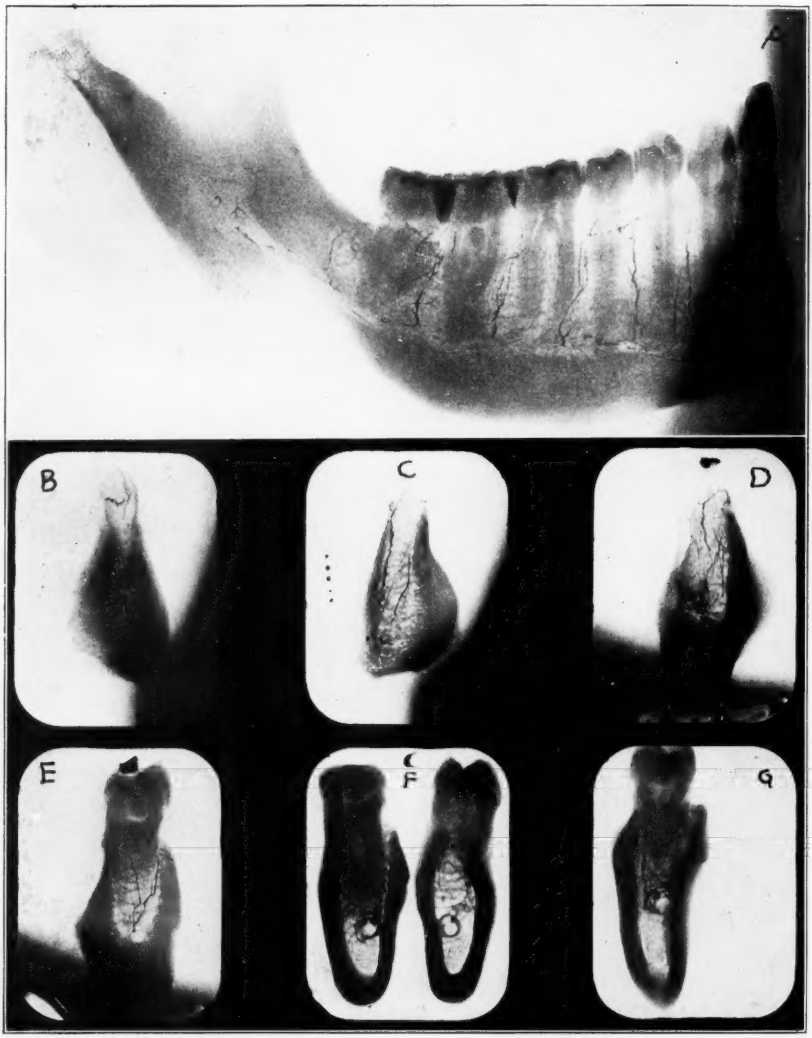
These specimens were injected a few hours after the death of the subject in the morgue of the Cincinnati General Hospital. The manipulation of the injection was as follows: A metal cannula was inserted in the external carotid artery and a normal salt solution heated to about 85°F. was injected with a metal injection syringe, capacity 50 cc., and hand pressure to wash out the vessels; the litharge injection, which had been held at a temperature of 85°F. followed right after. A compound of 250 gms. of litharge suspended in 1000 cc. of glycerin was used for injection. The jaw was removed after the injection hardened in a 4% solution of formaldehyde, and X-rayed.

Patient, age about 50 years, white, X-rays of a mandible with the gum tissue removed.

Figure 11.



A. Frontal part of the injected jaw with the soft tissue removed.
B. Right mandible, injected, with gum tissue in situ.
C. Left mandible, injected, with gum tissue in situ.



A. This is a roentgenograph of an injected specimen from which all of the soft tissue had been removed. Note the ascending arteries between the teeth. This mandible was cut into a series of vertical cross sections which are shown.

B. Bone septum between inferior cuspid and first bicuspid. Notice small artery circling the socket.

C. Bone septum between first and second inferior bicuspid. Quite a good blood supply on the lingual aspect.

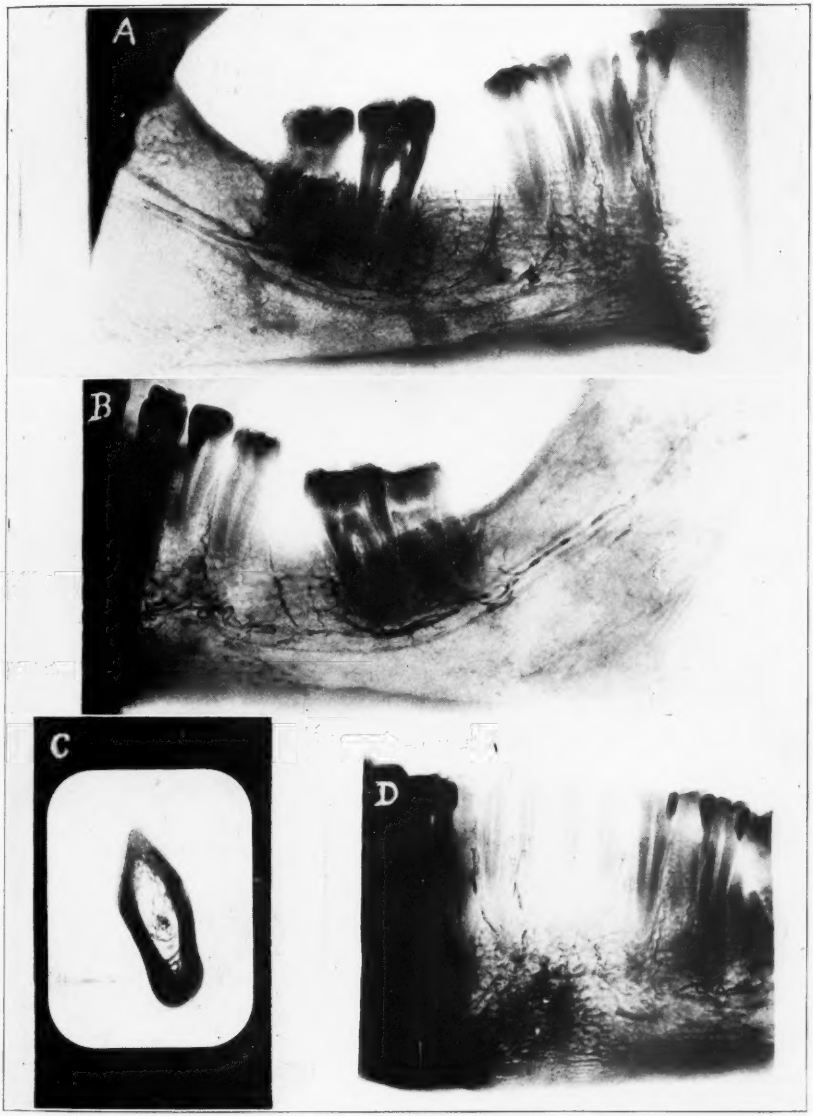
D. Same septum between second bicuspid and anterior root of first molar.

E. Anterior aspect of posterior root of the first inferior molar, tooth and bone being cut thru without removal of root. If pus in an appreciable quantity should collect about this apical area, what important vessels might be involved?

F. Second inferior lower molar cut in half between the roots.

G. First molar cut in half between the curved roots.

Figure 13.



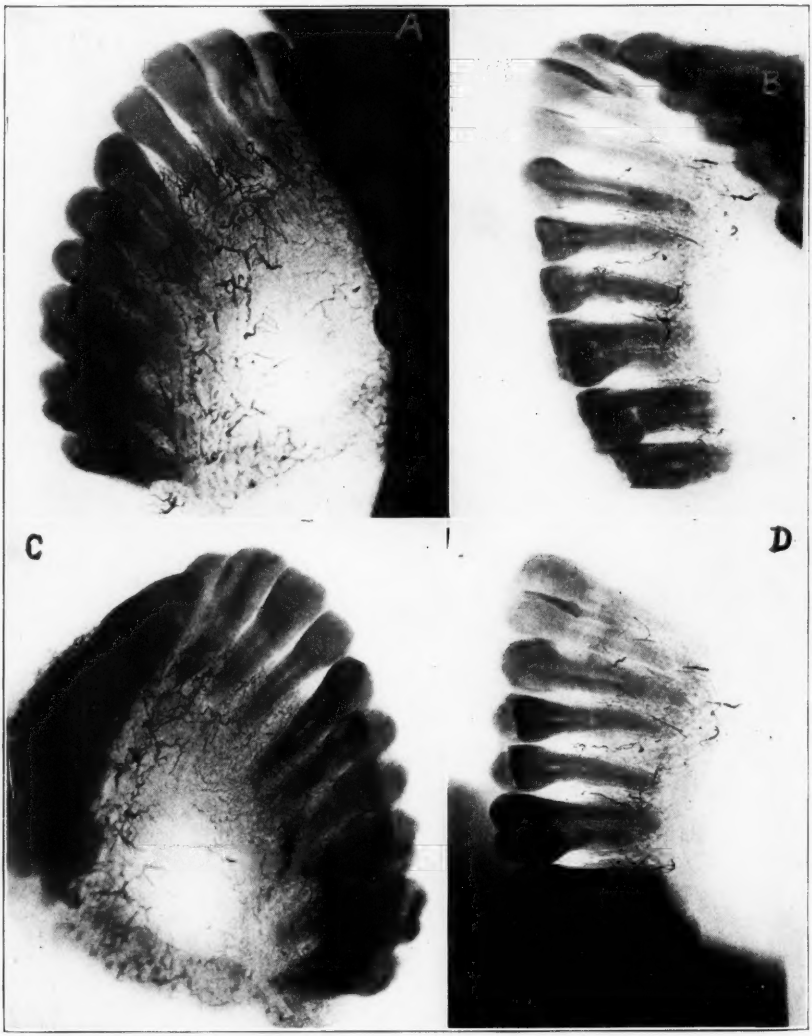
A. Note the arterial branches passing up from the main artery.

B. Note the bone space once occupied by the first molar.

C. Transverse section thru this region, showing no trace of the tooth socket. In the center is the inferior dental canal with branches going thru the bone apex.

D. X-ray of the anterior of the mandible.

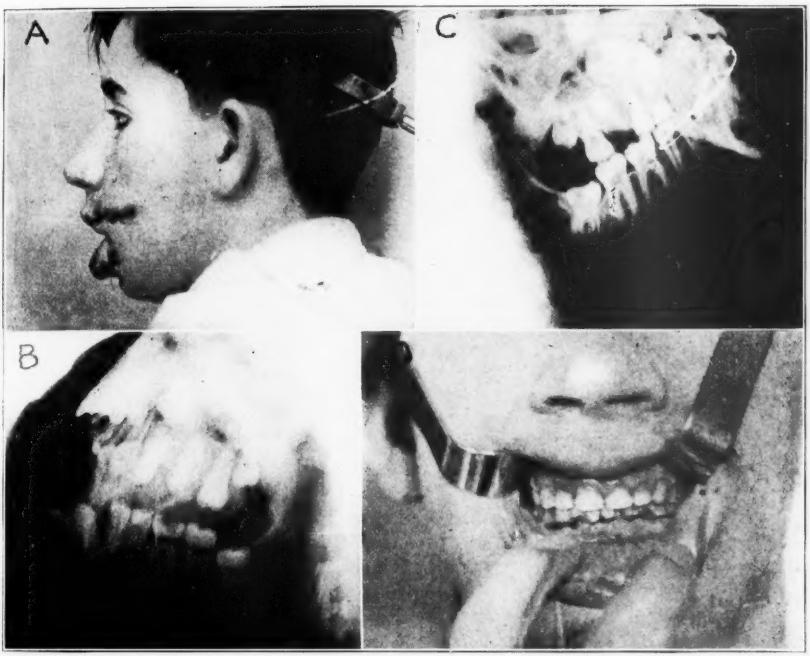
Figure 14.



Roentgenograms of:

A. The upper injected jaw with soft tissue in situ.
B. The upper injected jaw with soft tissue removed.
C. The same jaw, plate placed above the specimen.
D. The same specimen with plate placed buccally.

Figure 15.



"Your attention is directed to some cases of fracture that came into the General Hospital and which I took under my observation. A young man split the lower anterior teeth out in an elevator accident, turned them out just like the back of a book.

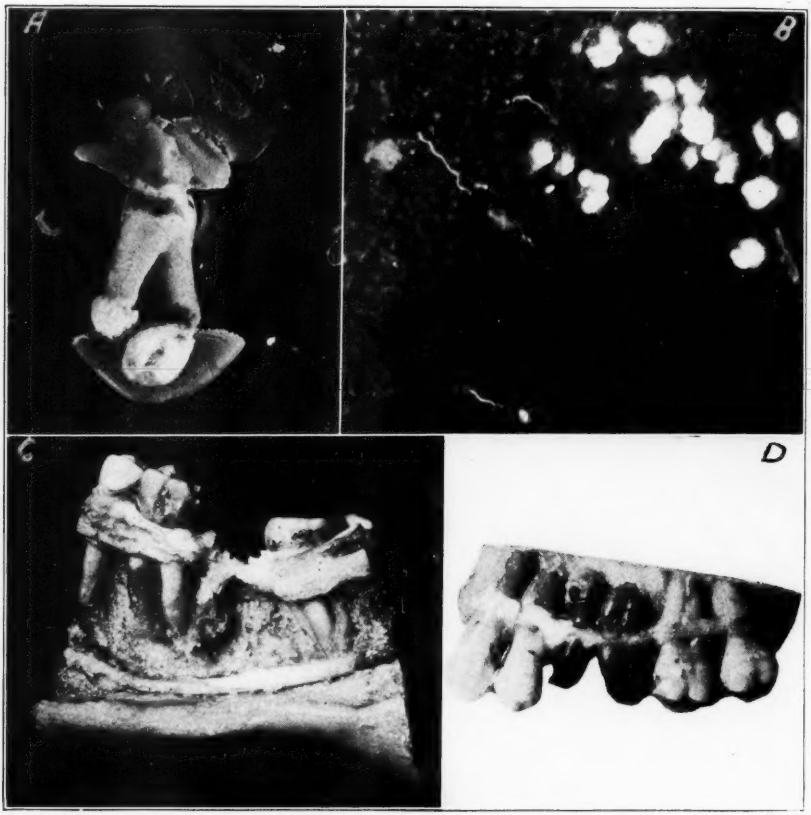
A shows the appearance as he came into the Hospital when Dr. MacMillan took charge of the case—a boy about sixteen years of age. The question here is: why do we expect that the bone and tissue which were split will have some chance of maintaining their vitality?

B shows where the teeth were split out. You can realize that inasmuch as the blood supply is going parallel to the long axis of the teeth there is not so much danger of the blood supply being ruptured in that direction and also the nerve supply which accompanies the blood supply.

C shows the patient under an anesthetic. This bone and all were forced back and wired together.

D shows the boy with the teeth wired in position. Notice the articulation. It remains to be seen whether the teeth will retain their vitality or not. They have been tested out and they are vital at the present time and I think the direction of the blood supply has something to do with the maintenance of that vitality."

Figure 16.



A. A superior molar with a couple of granulomas which were attached with beeswax to hold in place. A hospital patient, female, colored, 26 years of age, who had been admitted to the hospital for treatment for lues. A Wassermann was taken, which showed to be highly positive. Patient was sent to the dental clinic for extraction.

B. A section of the granuloma. Diagnosis—lues. Levaditi stain, all sections show numerous spirochetes. These, however, do not appear to be the treponema, probably mouth spirochetes. Other bacteria found.

C. Patient, over 50, colored. Note granulomas on roots of first molar, the granuloma tissue growing up in socket of second molar which had been previously lost, the roots of the third molar very close to inferior dental canal, the vessels and nerves in inferior dental canal seem to be enclosed in a membrane binding them in a bundle.

D. Patient, under 50. Note granuloma on root of second bicuspid. Large crowns and short roots.

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VOL. 6 JUNE, 1919 NO. 6

Editorial Department.

DID "THEODORE ROOSEVELT'S TEETH KILL HIM?"

A short time ago a most readable article appeared in a great American Journal entitled, "Theodore Roosevelt's Teeth" with the startling sub-title "A Great Man Cut Down In His Prime Because of an Infected Tooth." A likeness of Mr. Roosevelt showing his teeth in a characteristic way, demanded the attention of the reader and two radiograms headed the article for emphasis. The first paragraph met every requirement for sealing the attention. "Those flashing white teeth won him millions of friends—yet one of those teeth killed him."

No one doubts the motive of the journal in publishing that article. It is clearly stated, "If the widespread interest in Roosevelt's case awakens his fellow countrymen to the vital importance of caring for their teeth, Roosevelt will have given an inestimably valuable gift to his country." In every word of that sentence is voiced the undoubted sincerity of the editorial staff. The influence of this magazine is primary in American journalism; every page is dedicated to culture, education, inspiration. Reading this article, however, one cannot help asking why the editor did not find someone to present the subject who had more than a passing acquaintance with the facts involved. Surely the ranks of dental educators would have afforded a man capable of the happy phrase and at the same time sufficiently versed in the facts to state them truthfully. The reception of the story is inevitable. People will read and believe; and some of the statements made are worth believing. But the beautiful fabric is such a complex of truth and error, such a mixture of virtuous instruction and misstatement that one wonders whether the measure of truth told, the motive involved, the smoothness of diction will compensate for the effects of the unprovable declarations. The editor of this magazine is not a Jesuit; he refuses the dogma that the end justifies the means.

A dentist's reaction to anything dental arising outside the professional pale is difficult to analyze. His experience in having the structure with which he is intimately associated discussed unrestrictedly is new. No other specialty of medicine is similarly discussed by the laity. No other bit of human anatomy was ever so popular as the tooth, and the reason for it is obvious. People speak of the teeth as they do the weather or clothes or play, and not infrequently with a well chosen nomenclature. When a humorist uses teeth or the dental office as fun producers, the dentist laughs with the rest; when the physician discusses teeth, the dentist is apt to criticise the awkward terminology and wonder why the mouth became part of the digestive system so late in medical consideration and then so superficially. When a dentist enters popular journalism his co-laborer suspects him of having a hobby to ride or a fad to advance. He accepts just criticism without resentment but such far-reaching misrepresentation as the article in question presents makes him belligerent. The mouth, teeth, health, dentistry deserve the truth; the dentist in his relation to them all deserves the truth and the dentist's clientele deserves the truth.

"And one of those teeth killed him." Who has gone on record to that effect? Was that statement proved in Mr. Roosevelt's case? We will grant the possibility that oral infections may begin the process that results in death but we question a man's right to make such a state-

ment, his right from the standpoint of the facts involved, his right as his words effect the profession, his right as his words effect the readers of the statement. Who determined the cause of Mr. Roosevelt's death? And what was the method of determination? Do no other foci contain the same flora as are usually found at the apices of teeth? May bacteria from other foci not have done the damage? Scientists are quite agreed and have been for some time that infecting dental foci may have fatal effects, but it is quite certain that no one except a popular writer would dare make such an assertion as the one quoted about Mr. Roosevelt's death.

"Any person," says the popular adviser, "who has had any dental work done, especially capping or crowning, would do well to have an X-ray photograph taken of his mouth because the X-ray is the only sure means of knowing the condition about the roots of the teeth." Again a mixture of truth and error! No argument is made against the wisdom of having X-rays made of devitalized teeth, having it done regularly at not too great intervals indeed, but who would venture to say the X-ray is the "only sure means of knowing the condition about the roots of teeth?" One is led to believe that the writer never interpreted an X-ray or ever became acquainted with men who do it. When the contributing elements of wrong diagnosis of X-rays are enumerated, when the varied interpretations of lines and shadows on the film are recalled, when the procedures based upon X-ray readings by different operators are contemplated, faith in the X-ray as a final resort in diagnosis begins to waver. It is safe to say that no reliable dental or general surgeon would subscribe to the assertion quoted.

We would call attention to a definition and an explanation given, neither of which, perhaps, is of importance from the patient's viewpoint, both of which, however, are suggestive of the author's incapacity for his task. "A pulmonary embolus is a blood-clot formed in the lungs." This definition is doubtless made for the sake of brevity; made for retention in the lay mind, but the truth is popularized out of it. The definition suggests what an embolus never is; a blood-clot is simply one of a number of things that an embolus may be. "If there is an abscess at the root of such a tooth, the multiplying bacteria must find an outlet. They cannot enter the mouth because the way is closed by a cap, so they attack the bone which is porous enough to let them thru." Must fact be garbled to this extent to be acceptable to the American populace?

Suggesting a remedy the writer urges that "this is a matter which can be controlled by insisting on good dentistry." It is amusing to apply the remedy to the problem in question. Good dentistry, forsooth! What is it? Who does it? Who adjudicates? And finally, how is the

person most interested to tell when he has it or does not have it? Imagine a patient in the presence of a dentist urging this point! The writer is really a humorist. So long as good men differ in judgment, so long as hands fall short of ideals, so long as the profession is divided on many fundamental procedures, so long as dentists like others do or do not according to the keenness of their moral sense, so long as dentists acquire and retain their practice upon the salability of their personalities, what can such terms as good dentistry and good dentists mean in lay parlance?

The plea continues for greater preventive measures, and this deserves attention. The only trouble with it is that the means to that end are urged from the wrong source as before. Quoting from a physician in charge of a hospital for the insane he says, "Proper care is entirely different from what the usual examination, (dental) reveals, and only by refusing to have devitalized teeth crowned and insisting upon having these teeth extracted, can we hope for better teeth." Will the usual patient urge the extraction of his sound, comfortable, serviceable tooth? Not unless frightened by such a line as, "And one of them killed him." And speaking of the usual examination, one is led to ask, "To what kind of dentist did the doctor go? Apparently the same kind as cared for Mr. Roosevelt, for if the X-rays shown are of the great man's teeth, and providing that his dentist ever saw them, then neither the dentist nor the great ex-president was as intelligent about teeth as the average citizen is expected to be. Prevention is a common word in dental annals. The prevention of devitalization is an object devoutly wished for by the profession. To accomplish it, dentistry hopes and prays, knowing that it depends almost entirely upon popular education, but the dental profession wants the public educated in the truth, not falsehood or semi-falsehood.

When an article like the one quoted is possible it indicates that the pendulum has swung a long way. Locating the blame is not the purpose of this editorial altho we believe that it is not so difficult as at first it may seem. There is small doubt that education of the physician and dentist has much to do with it. In the latter this magazine is interested, profoundly, vitally. Dentistry, like other phases of the great medical and surgical world, will never be reduced to orthodoxy, but it can be brought to a better unanimity than now exists. One man well known in the profession says, "Once an abscess, always an abscess." Another equally well known essays to treat and cure. One man reading a radiogram says, "The tooth should be extracted." The next says, "Ridiculous! It can be saved." One man declares that Pyorrhea can be cured, and again, he is laughed to scorn. And between these disputants exists

a barrier at once mediaeval and ecclesiastical in its relentlessness and irreconciliation. Such is the conflict that prevails thru medicine and dentistry, but back of the superficial conflict is the steady, earnest effort of science striving to find the truth. On some subjects it has spoken indisputably. We wonder why there is not more unity when such are concerned. Safety is more apt to be in its halls than in the hurried marts of untabulated and unstudied activity, and it must not be supposed that those who lead in scientific endeavor are removed from the common thorofares where men with their myriad ills pass by.

THE THINGS THAT ARE CAESAR'S.

Editor's Note:—Under this general title, ONE HUNDRED PER CENT COLLECTIONS, a series of articles has been prepared by the Savings Division of the Treasury Department, United States Government, for The Journal of the National Dental Association. These articles will appear monthly. They are earnestly commended to the thoughtful consideration of the dental profession.

In the earlier stages of the War, an anxious man appeared before a high Government official. He was concerned as to the future of his business, and that of other men in the same line of industry. Frankly, he was frightened, and he said so, at great length. When he had talked himself out, the official, who had given up his own business to serve the Government, looked at him quietly.

"If you're a man," he said, "you'll see that you get what is coming to you. If I'm a man, I'll see that you get no more."

The business man reflected a moment. "That's fair enough," he said, and on that elementary basis was developed a cooperation which extended thruout the War, and maintained the industry in splendid condition.

How does the average dentist measure up to this specification for a man?

Professionally, he goes far. The dental surgery developed in the United States is pre-eminent in the world. From London to Vladivostok, the "American dentist" is sought. In the waste places of the planet, a thousand miles is thought not too far to travel if he is to be found at the end of the journey. Clearly, the dentist is delivering the goods, and in doing so he has at once elevated the standards of his profession and performed a national service of rare worth.

The other side of the shield is not so bright. The dentist does not get what is coming to him. In theory, his collections are sixty, or eighty, or ninety per cent, but the theory is fundamentally untrue. There is, in fact, a 100 per cent collection of every dollar's worth of professional service a dentist renders. Somebody pays for it. If the patient does not, the dentist does, or some other patient must.

Here is a three-way justice, or injustice. It starts with the dentist. If he serves the public to the extent of a ten thousand dollar annual practice, and receives only $7,000 in fees, there is a shortage of $3,000 and it is going to be paid. Manifestly, the dentist should not pay for it. To spread it over the bills of thrifty patients would be unjust. It can rightfully be paid only by the person who owes it, nor can the dentist evade his share of the responsibility of seeing that it is so paid.

Various devices to this end are now in fairly general use, and none of them have solved the problem. If they had, it wouldn't exist. The "monthly statement" is not a cure, nor is the personal dun. The bill collector, as such, or the attorney who handles collections, is not a cure, altho some of them show amazing versatility. They are but palliatives.

The 100 per cent collection, properly distributed, is purely a question of thrift, and thrift is a matter of education.

This is demonstrable. More, it has been demonstrated; some dentists have known it and profited by it for a long time.

Thrift, it so happens, is less a matter of chance than any other virtue. It runs in nations,—our not yet being one of them,—in whole sections of the country, in states, in parts of states, in communities, and in families. It is a hardy perennial, and when once rooted, persists for generations.

Thrift can be planted anywhere, with sure results, but there is no better place than a dentist's office. Here it is that the busy man finds a few moments of leisure, in the waiting room. He is alert and at his best because his mind is used to working under pressure during business hours. He may look at the rug or twirl his thumbs, to pass the time, but nine times out of ten he reads, and so does his wife.

This is the opportunity, and the experiment is simple. Instead of more or less ancient magazines, place ten leaflets on thrift and War Savings beside the little tray that holds your professional cards. The strong probability is that all will be gone by night, but the Chairman of your local War Savings Committee will supply, not only the first ten, but enough for the next day, and every day thereafter. Your intensive culture of thrift will have been started. You can help it along as much as you please in your conversations with your patients; it will develop more rapidly in this way, but anyhow it will grow. Nothing can stop it.

The nation looks forward to great prosperity. Prosperity depends upon confidence, and confidence is based upon character. Thrift is character's greatest stabilizer. The man who steadfastly practices it in the use of his time, his opportunities and his money, will have enough of each. He can afford even to be liberal; he can lend to the State in time of need.

And he can pay his bills,—your bills.

The government asks the continued cooperation of the dentists of the United States. It will benefit you and it will aid the nation. Will you cooperate?

(Discussion and suggestion along the lines of this article are invited, and should be addressed to the Savings Division, Treasury Department, Washington, D. C.)

WHY DON'T THEY PAY THEIR BILLS?

Dr. John Smith, a dentist in Smithville, has a large practice. His collections run from 45 per cent to 60 per cent.

Dr. James Jones, dentist in Jonesburg, has a practice as large as that of Dr. Smith of the same class of people, but his collections average 95 per cent or better.

Why?

Both Smithville and Jonesburg are towns of the same size. Both made up of the same average type of everyday folks, with about the same average income. But Dr. Jones' patients pay and Dr. Smith's patients do not.

Now 100 per cent of the average citizens are instinctively honest. And everyone of that 100 per cent knows that when he receives the benefit of his dentist's services and fails to pay his dentist's bill, that he is more or less dishonest. Instinctively he is prompted to pay that dentist's bill. Why doesn't he do it?

Generally he doesn't do it because he hasn't the money. The money that ought to go to the dentist is expended out of the family or individual income for some other purpose. It goes to some purpose which is closer to the everyday life of the man or woman who still owes the dentist. It usually goes for something that is of

less ultimate importance to the patient, but it goes. It is spent as the occasion arises. It is spent that way because the individual usually spends that way. It doesn't go to the dentist because the dentist is not one of the daily spending outlets of the individual. It goes to some less important use because the less important use happens to be at hand, and the spender is spending thoughtlessly.

If you will examine closely conditions in Smithville and Jonesburg you will find that there is an essential difference between the two communities as communities.

Jonesburg is thrifty.

Smithville is unthrifty.

Dr. Smith has happened to locate in a community where the majority of the people are not savers. They have not acquired the habit of thrift. The savings banks of the town are few and struggling. The retail merchants are fighting for existence with the handicap of heavy lines of extended credits. The people are accustomed to live from pay day to pay day, without giving serious thought to the future. Therefore the dentist's bill is an extraordinary expenditure, not an ordinary one, and the community is used to taking care only of ordinary day by day expenditures.

Dr. Jones has located in a community where the majority of the people are thrifty. They have acquired the habit of saving first. They balance their future needs as well as their present needs with their income, and provide for their future expenditures. The savings banks of Jonesburg are prosperous and numerous. The retail merchants are doing a thriving cash business, at prices lower than those obtaining in Smithville. Pay day in Jonesburg means a heavy run of deposits at all of the banks. When extraordinary expenditures are necessary, the people of Jonesburg have the money with which to make them. Therefore they are always able to pay their dentist's bills promptly.

What is the remedy? Is Dr. Smith to desert Smithville, and go to Jonesburg to compete with Dr. Jones for the thrifty practice there? That would mean deserting a good practice, and starting all over again. It would leave Smithville without a dentist. This is not the remedy.

The remedy is to make Smithville a thrifty community. Dr. Smith can do his share to help. The thrift movement is sweeping thru the country and Smithville should join. Dr. Smith should at once join the movement. He should cooperate with his local Savings Director who represents the Federal Reserve System in his community. He should preach thrift in season and out of season. He should forward every activity which will contribute to the success of the thrift movement generally. By his aid Smithville can be changed from a thriftless town to a thrifty town, and his 45 per cent collections can be built up to 100 per cent.

What is true of the community is true of the individual, for the characteristics of the community are only the same total of the characteristics of the individuals making up the community.

Dr. Smith can do much by effectively preaching thrift among his own patients The slow-pay or no-pay patient who begins a bank account, or who begins saving thru investing in War Savings Stamps is on the road to becoming a good paying customer. His savings account is available for extraordinary expenses. He can redeem his War Saving Stamps if necessary to pay a pressing bill. And he will do it, because he instinctively will pay that bill if he has the money in any form.

Army and Navy

PERFORMING 112,440 DENTAL OPERATIONS.

The following conversation was heard on a Northwestern train one afternoon:

"Where yuh going?" asked one Bluejacket of another. "Chicago," was the reply.

"Have a big time, I guess?" was the second query.

"Nope, not me," with a sigh. "I gotta date with a dentist on Madison Street."

That bit of repartee showed definitely that there are some men in service ignorant of the fact that the Navy in general, and Great Lakes in particular, maintains a Dental Department that one cannot afford to slight in preference to civilian dentists. It is admitted that among some enlisted men there is a certain lack of confidence concerning the work done by the Dental Department. This feeling exists, however, only because these men know no better.

Many men, upon finding out their teeth require attention, rush to a civilian, paying regular fees from their hard-earned wages for the privilege, if it is a privilege. They do this without giving the Naval Dental Department a chance—that is certain. Because if they went to Dental Headquarters once they'd never go off the Station again to have the work done.

Yes, this is an argument to show that it is foolish to dismiss the Naval Dental Department without a thought. Not that the department needs customers! We should say not! Last year at Great Lakes they made 69,546 original examinations and 112,440 operations. They are very busy and slow business isn't the plea. The plea is simply that credit should be given in a department that has done remarkable work here—a department whose war time record was second to none in this, the World's Greatest Naval Training Station.

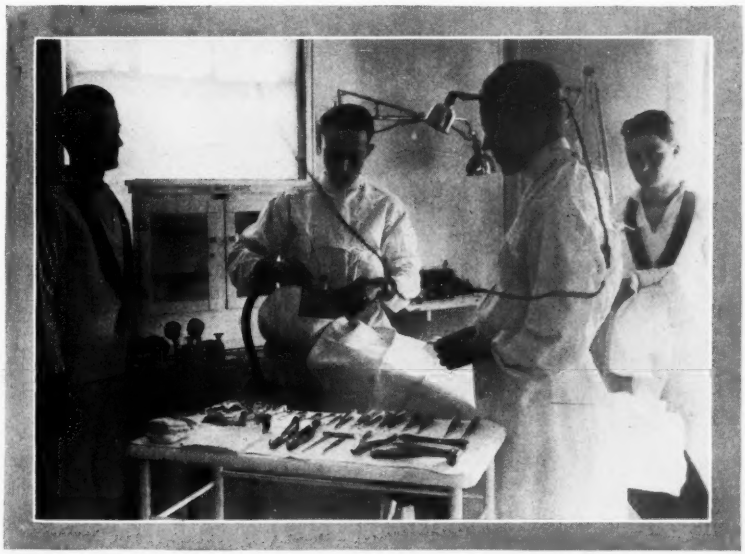
As Lieutenant-Commander A. F. McCreary, Senior Dental Officer, pointed out, the Navy takes its time in the matter of teeth. There is no object in hurrying; it isn't a case of making money with the dentist. He works slowly, surely and completely. When a job is done it's done right. In the event some error has been made, which of course, is not impossible, the job is done over again.

The X-ray machine, for instance, corrects, or "catches," a number of mistakes. This is an advantage that few civilian dentists can give you, owing to the fact that they haven't the machine in their operating room. At Great Lakes it is used regularly and whenever a root-canal filling goes wrong the machine discovers the shortcoming, whereupon the roots are filled over. This seems a small thing, but it saves many men hours of suffering and no end of additional trouble with the tooth.

Dr. McCreary reported at Great Lakes in March, 1917. At that time he was the only dental surgeon on duty. Now

take a glance at the photo showing the dental staff during the war period. Some growth! Dr. McCreary has been in charge of the dental department since he first reported and has helped it immensely by directing its great growth. From a complement of one dental surgeon it jumped to the largest dental department in the United States Navy.

addition to classes in advanced dental work. The success of this school was so great that it now seems a certainty that it will become a permanent part of the department. Owing to the signing of the armistice, the school was discontinued, but it is hoped that it will reopen as a permanent feature of the Regular Navy, the only school of its kind in existence.



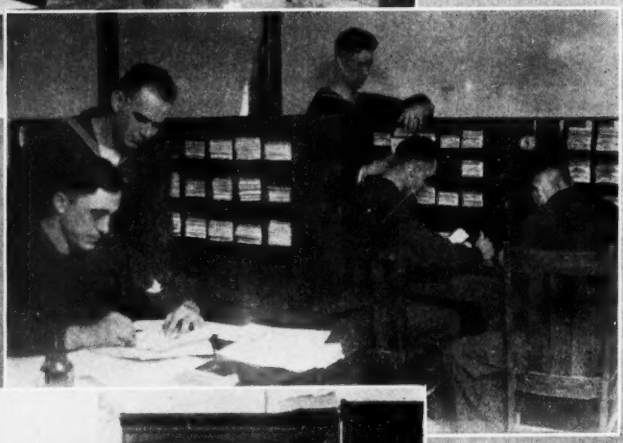
Oral Surgery—Above is the super-operating room in Dental Headquarters. All cases which demand special attention are treated here. The room is fitted with the latest and best equipment. Lieutenant H. C. Miller is prepared to make an operation, while Lieutenant (J. G.) A. L. Burleigh is assisting.

During the war the idea was conceived by the dental officer to open a school of Dentistry. This was done and two classes took the course mapped by Dr. McCreary and his assistants. The men reporting for instruction in the school were licensed dentists, but the need of teaching them the Navy way and Navy regulations was apparent.

Dentists coming into service had no idea regarding the manner of conducting themselves according to military courtesy. These regulations and "officer-like manners" were taught in the school, in

Each unit at Great Lakes has a dental operating room. Patients are received and treated here, but in the event an important operation is required he is sent to headquarters, where a super-operating room is maintained. This room is the last word in Oral Surgery. There is nothing that cannot be accomplished within its walls, the abundant equipment being of the latest and best manufacture. Any number of remarkable operations have been made in this room. And, Shipmate, if you ever have a difficult extrac-

Tomorrow at Nine.—At this desk appointments are made for the Bluejackets whose teeth need mending. Others can be seen waiting until they are called by the dentist to whom they are to report.



Record Room—Dental Records form a part of the Bluejacket's health record and entries are made each time anything is done to his molars.

A Big Post—Lieutenant - commander E. E. Harris, Dental Executive Officer, is a busy man. He is an important director in the largest Dental Department in the Navy. Chief Yeoman Little is his aide.

The X-Rays—In many cases the dentist can learn a great deal about his patient's condition with the use of the X-rays, a feature of Naval dentistry which is seldom seen in civil life. It assists in proving that the work has been done correctly.

Ouch! Ouch!—But this Bluejacket didn't say that. Furthermore, when he left the chair he claimed the job was absolutely painless.

Just a minute—If you give him that long, Lieutenant (J. G.) Walter Rehrauer, in charge of the stock room, can get anything required.

tion to be worked upon this is the place to go.

Camp Barry has the second largest number of operating rooms, headquarters being first with seven. There are five in the Outgoing Detention Camp. This, of course, is to take care of the Recruits. When a man reports for duty one of his most important events in detention is the examination of his teeth. If necessary, they are treated.

Whether or not work is done on the teeth, however, the man's dental records are made and forwarded to headquarters. Any subsequent work on the teeth calls for an entry in these records. Each time anything at all happens to him it is included in the dental record, which is a part of the enlisted man's health record.

These are some of the few features of the Dental Department. There are probably many more, but lack of space prevents us from narrating further.

The Dental Department is one of the most interesting in the Navy. There's one especially good thing about it—you don't have to wait in line. Go straight to the appointment desk, make the appointment, and report back at the designated time. You will then receive as good, if not better, treatment than you ever had in your life.

There's a slogan of the Great Lakes Naval Training Station Dental Department which should be chronicled here before this story goes to press. It is "Don't pull—fix." Of course we are referring to some irate molar which needs dental attention badly. But that molar (if it should so happen to be) will be cowed into "subservience" and "obedience."—*Great Lakes Recruit, May.*

VICTORY BUTTON AUTHORIZED.

Amendment to Circular No. 187, War Department, 1919, provides for a victory button.

Paragraph 1 of the circular is amended to read as follows:

"A lapel button to be known as the victory button, for wear on civilian clothes, will be issued to all officers, enlisted men, field clerks and members of the Army Nurse Corps, who served on active duty in the Army of the United States at any time between April 6, 1917, and November 11, 1918, and whose service was honorable. The button will be silver for those wounded in action and bronze for all others."—*Army and Navy Register, May 10.*

BE SATISFIED.

Don't kick at the high cost of every old thing. Be glad you don't live in Turkey. A Red Cross man writes that eggs in Constantinople are thirty cents apiece. They're not passed by the censor, either. Bread is eighty cents a loaf, milk ninety cents a pint, butter four dollars a pound and sugar two dollars a pound. Just imagine feeding a flock of wives at those prices. Two army officers, says the Red Cross man, stopped over night and had to pay two hundred and thirty-five dollars ($235) for lodging, breakfast and dinner. Wonder what they had to give the hat boy?

DENTAL CORPS ORDERS FROM WAR DEPARTMENT.

DENTAL CORPS

Maj. Frank B. McAdams to Pittsburgh, Pa., general hospital 24, for duty.

Capt. Arthur B. McCormick to Hoboken, N. J., port of embarkation, for duty.

Capt. Herman J. Brachman to general hospital 36, Detroit, Mich.

Appointments of following by commanding general, American expeditionary forces, France, confirmed:

To be Lieutenant Colonels, Dental Corps—Majs. Joseph A. Boarts, Grove W. Dunham, John McD. Eveleth, Charles S. Jack, Rea P. McGee, Archibald I. Miller, Wm. H. Potter, Wilbert J. Scruton, John Voss and Otis H. McDonald.

To be Majors, Dental Corps—Capts. Lawrence E. Aldrich, Edwin C. Baker, Egbert E. Baker, Fred A. Beaty, Lloyd Y. Beers, Edgar T. Blocher, Frank W. Boville, Frederick J. Brockman, James A. Brown, Walter T. Clark, Henry S. Davis, Wm.

W. Irving, Laverne H. Jacob, James B. Jones, Ormsby Keselring, Edward F. Lafitte, Arthur Lankford, Wm. B. Ley, Robert R. Luce, Charles A. Mallon, Everett E. Mac-Gibbon, Frank B. McAdams, Daniel F. McCarthy, Wm. McDoughall, Earl N. McCue, Robert H. Nones, Jr., Wm. B. Noble, John S. Owens, Perry H. Plummer, Matthew F. Carney, Royal E. Wight, Alphonso F. Wilbur, John B. Williams, Robert L. Donaldson, Benjamin J. Durham, Bion R. East, Albert W. Farley, Charles W. Freeman, Otto F. Freitag, George N. Frost, Walter D. Gochenour, James B. Harrington, Arthur A. Hoffman, Carl M. Holland, Guy R. Harrison, Carl A. Anderson, Thomas L. Rice, Arthur C. Roblin, Francis J. Rogers, James W. Ross, Bertram S. Rathwell, Frederick H. Saunders, Stanton L. Sherman, Edwin Shoemaker, David S. Smith, Harry R. Smith, Ivan E. Smith, Wm. S. Sykes, Harry A. Tuckey, Thomas H. Tye, John C. Vander Voort, Clarke B. Weeks, Floyd E. West, Raymond H. Williams and Adolphus E. Worsham.

To be Captains, Dental Corps—1st Lieuts. Albert M. Aronberg, Jacob Asch, Austin C. Bamford, Emory C. Bardwell, James E. Ryan, Chester L. Sandiford, George E. Sandoz, John E. Schmidt, Arthur V. Seifert, Leo Shonfield, Wm. M. Slowe, John J. Small, Victor B. Souby, George E. Staats, Frank C. Starr, Robert W. Starr, Jr., Elmer Steiner, Leo Stern, Chelsa L. Storms, Beaman Story, Sylvester H. Straessley, James N. Sturdivant, Horace E. Metzner, Edwin Miller, Edgar J. Moore, Walter McN. Morgan, John D. D. Morrison, Robert E. Motley, Wm. W. Moyer, Raymond F. Mulcahy, Reginald S. Murdock, Robert H. Murphy, Wm. G. Neale, Frank B. Netherland, Daniel B. Newton, Gerard B. O'Neil, Edwin J. Orton, Harrison L. Parker, Francis C. Bartleman, Wm. A. Barton, Lonzo G. Bean, Bernard L. Riley, Edgar C. Berryman, Beverly M. Epes, Charles H. Cole, James J. Mansfield, Howard E. Swartz, Francis H. Sylva, Campbell G. Tipton, Charl J. Torrence, Norman W. Trimpi, Henry P. Wadsworth, Perry H. Walet, Roy P. Walton, Forest W. Ward, Cecil D. Washburn, Marvin V. Welcher, Richmond Wells, Roy E. Wheeler, Warren S. Whittle, Ralph H. Wickens, Marcus F. J. Weilage, Arnold E. Zarawski, Hope H. Payne, Henry C. Petray, George W. Phelan, Charles F. Pickering, Charles E. Porter, Rollo I. Pusey, Joseph L. Rahm, Samuel L. Rambo, Clarence H. Rangeley, James H. Ross, Jr., Jerome A. Rapp, Edwin J. Reichel, Louis E. Reif, Buford A. Rice, George George A. W. Rigg, Arthur C. Rohde, Thomas C. Joseph, Starling E. Kay, John S. Kellogg, Edmund J. Kelly, Claude M. Kemper, Melvin H. King, Leroy E. Knight, Ralph M. Knight, Clarence F. Kohlmeier, Harold R. Lamb, George Le R. Lansdale, Austin L. Lawrence, Louis Lesser, Clifford E. Lewis, Harvey N. Lewis, Harold T. Lucas, Wm. R. Lutz, Charles F. MacDonald, Jr., Charles W. Hlavac, Thomas A. Holton, Percy Horridge, Harry L. Hosmer, George L. Felcher, Leroy M. Fink, Frederick L. Finnegan, Milburn M. Fowler, Stephen F. French, Norman E. Gardner, Clark R. Giles, Ralph E. Gill, Carolus R. Given, Malcolm Goddard, Wm. E. Graf, Ed Granger, Charles J. Gray, Leslie C. Bell, Kenneth B. Belinger, Howard F. Berkey, Cline S. Beurman, Owen I Bird, George C. Booth, Harry F. Bohle, Harry E. Bouden, Harry N. Boyne, Edward S. Bracken, Frederick DeS. Brent, Bissel B. Palmer, Jr., Henry A. Delaney, Alan Maclachlan, Arthur B. McCormick, Walter H. McCreary, John H. MacDermott, Wm. H. Melnea, Matthew E. McKenna, Richard W. McLean, George C. McMullen, Thomas W. Magner, Agustin L. Magruder, Charles H. Manning, Herve C. Manon, Albert P. Matthews, John R. Maxom, John R. Merrill, Jr., Harry C. Metz, Archie R. Houns, Marion C. Izler, Cyrus C. Jones, Edward C. Jones, Charles S. Greaser, John P. Hacha, Robert W. Hammons, Gordon W. Hannah, Henry L. Harris, Thomas J. Hartigan, Charles P. Hatrick, Cecel R. Hays, Wm, J. Heffern, Otto B. Hinz, Kenneth Hillyer, Harry W. Hennis, Elmer J. Henn, Arthur E. Brown, Charles H. Brown, John D. Brown, Jr., Merritt T. Brown, Alexander C. Browne, John B. Bruns, Arthur G. Buehler, Harold H. Buehler, Richard H. Burkhart, Milo Bushong, Lucius A. Butler, George L. Cassel, Charles L. Cassell, Stanley W. Clark, William J. Clegg, George A. Coleman, Joseph A. Colman, George W. Cook, Faber W. Croll, William G. Crosby, Harold W. Crowell, James A. Cunha, Homer C. Darrah, Evan W. Davis, Charles D. Dawkins, Burrell B. DeHaven, Charles G. Dentry, Jr., Herbert Dewar, George W. Dierks, Roger L. Dill, Frank D. Donlevy, Lew W. Dougherty, Willard L. Ellsworth, Hubert H. Elslager, Junius F. Emerson, Lee M. English, LeRoy M. Ennis, Arentz J. Ericson, Stanley G. Ewen, Arthur W. Ewin, Orville N. Fansler.

—Army and Navy Register, April 26.

Maj. Bion R. East, Walter Reed General Hospital, D. C., for duty.

Maj. Arnett P. Matthews, to Camp Lewis, Wash., for duty.

Capt. Arthur C. Buehler, to Aberdeen, Md., Proving Ground, for duty.

Capt. Henry P. Wadsworth, to Southern Department for duty.

Capt. Harold H. Buehler, to Curtis Bay Md., ordnance depot for duty.

—Army and Navy Register, May 3.

Capt. Harold H. Buehler to Camp Pike, Ark., for duty.

—Army and Navy Register, May 10.

Col. Alden Carpenter to Washington for duty in attending surgeon's office.

Lieut. Col. John A. McAlister, Jr., and Maj. James G. Morningstar to Newport News, Va., port of embarkation, for duty.

—Army and Navy Register, May 17.

NATIONAL SOCIETIES, 1919.

October.

20-24—New Orleans, National Dental Association.

20-24—New Orleans, National Association of Dental Faculties.

18-20—New Orleans, National Association of Dental Examiners.

20—New Orleans, Delta Sigma Delta.

20-24—New Orleans, Xi Psi Phi Fraternity.

20-24—New Orleans, Association of Military Dental Surgeons.

17-18—New Orleans, International Society of Prosthetists.

20-24—New Orleans, Psi Omega Fraternity. Grand Chapter meeting and National Alumni Chapter meeting.

STATE SOCIETIES.

June.

9-10-11-12—Kentucky, Louisville.

11-12-13—Georgia, Savannah.

12-13-14—New York, Syracuse.

18-19-20—Florida, Tampa.

18-19-20—New Hampshire, Manchester.

19-20-21—Colorado.

19-20-21—South Carolina, Columbia.

23-24-25-26-27-28—California, San Francisco.

25-26-27—North Carolina, Asheville.

26-27-28—New Mexico, Albuquerque.

Maine. Place to be announced.

Maryland, Baltimore.

Utah, Ogden.

July.

8-9-10—Wisconsin, Milwaukee.

14-15-16-17—Washington, Seattle.

16-17-18—New Jersey, Atlantic City.

24-25-26—Montana, Butte.

September.

4-5-6—Tennessee, Nashville.

October.

21—Louisiana, New Orleans.

Rhode Island, Providence.

December.

2-3-4—Ohio.

DATES TO BE ANNOUNCED.

Arizona, Phoenix.

Virginia, Richmond.

THE LAST CHAPTER OF THE NEW MEXICO DENTAL LEGISLATION.

Under the new law now in effect all applicants must take the examination, and must present satisfactory evidence of having graduated from the recognized dental school, either by presenting his diploma or by sworn statements from some authorized person that he is a graduate of same. Application blanks furnished by the Board.

The examination will consist of both written and practice, written in such subjects as taught in the Class A and B dental schools, the practice to be of work in the mouth as selected by the examiners sufficient to test the skill of the operator, and the applicant is instructed to bring models for full denture, with two separate models for crowns. These may be made and mounted on articulators before coming.

Applicants will be expected to come

fully prepared to do all classes of work, as no excuse will be taken for lack of equipment. Board will furnish chairs for operating and tables for laboratory work.

The next examination will be held in Albuquerque, beginning June 23, 1919.

M. J. MORAN, Secretary,
Deming, N. M.

MAINE DENTAL SOCIETY.

The Maine Dental Society will meet at the "Breakwater Court," Kennebunkport, Maine, June 25, 26 and 27.

B. C. GRAFFAM, Secretary,
655 Congress St., Portland, Maine.

VIRGINIA STATE DENTAL ASSOCIATION.

The next meeting of the Virginia State Dental Association will be held at Richmond the week of August 25th to 30th inclusive.

HARRY BEAR, Asst. Secy.,
410 Professional Bldg., Richmond Va.

CALIFORNIA STATE DENTAL ASSOCIATION.

The meeting of the California State Dental Association will be held at the University of California Dental School, First and Parnassus Ave., San Francisco, June 23 to 27, inclusive.

JOHN E. GURLEY, Secy.,
430 Post St., San Francisco, Cal.

COMMITTEE OF DENTAL EXAMINERS—ILLINOIS.

The next meeting of the Committee of Dental Examiners for the examination of applicants for license to practice dentistry in Illinois will be held in Chicago, the week commencing Monday, June 23. For application blank and further information, address the Department of Registration and Education, Springfield, Ill.

SOUTH CAROLINA STATE BOARD OF DENTAL EXAMINERS—CHANGE OF DATE.

The meeting of the South Carolina State Board of Dental Examiners has been postponed until June 30th. The examinations will begin promptly at 9 o'clock, Monday morning, June 30th, at Bamberg, S. C.

All applications must be in the hands of the secretary by June 20th.

Application blanks and further information may be obtained by addressing,

R. L. SPENCER, Secretary,
Bennettsville, S. C.

MEETING OF THE TENNESSEE STATE BOARD OF DENTAL EXAMINERS.

The next meeting of the Tennessee State Board of Dental Examiners will be held in Nashville, Tenn., June 30th, 1919, for the examination of candidates for registration.

All applications must be in the hands of the Secretary on or before the 20th of June. For further information address F. W. Meacham, Secretary, 911-12 Hamilton National Bank Bldg., Chattanooga, Tenn.

OKLAHOMA STATE BOARD OF DENTAL EXAMINERS.

The next meeting of the Oklahoma State Board of Dental Examiners will be held in the Senate Chamber, State Capitol Building, Oklahoma City, on July 14th, 1919.

A recent law enacted provides for an annual license fee of $1.00 and further provides that failure to pay automatically cancels the license to practice in the state.

For further information address,

H. R. WATKINS, Secretary,
240 American Nat'l Bank Bldg,
Oklahoma City, Okla.

SEMI-ANNUAL MEETING OF THE RHODE ISLAND BOARD OF REGISTRATION IN DENTISTRY.

The regular semi-annual meeting of Rhode Island Board of Registration in Dentistry for the examination of applicants will be held in the State House, Providence, R. I., July 1st, 2nd and 3rd, 1919. All applications with proper fee must be filed one week previous. For further information address,

ERNEST A. CHARBONNEL, Sec'y,
334 Westminster Street,
Providence, R. I.

MEETING OF THE MAINE BOARD OF DENTAL EXAMINERS.

The Maine Board of Dental Examiners will hold their regular examination, beginning July 1st, 1919, at 8:30 at the State House.

All applications and fee of $20.00 must be in the hands of the Secretary by June 21st.

The examination for Dental Hygienists will be given at the same time, fee $10.00.

WILL S. PAYSON, Secretary,
Castine, Maine.

TENNESSEE STATE DENTAL ASSOCIATION.

The fifty-second annual meeting of the Tennessee State Dental Association will be held at the Hotel Hermitage, Nashville, September 4-5-6, 1919.

JAMES J. VAUGHN,
Chairman Publicity Committee,
Nashville, Tenn.

THE INTERNATIONAL SOCIETY OF PROSTHETISTS.

The International Society of Prosthetists will hold their annual meeting in New Orleans, La., October 17-18, 1919.

DAYTON D. CAMPBELL, Secretary,
Kansas City, Mo.

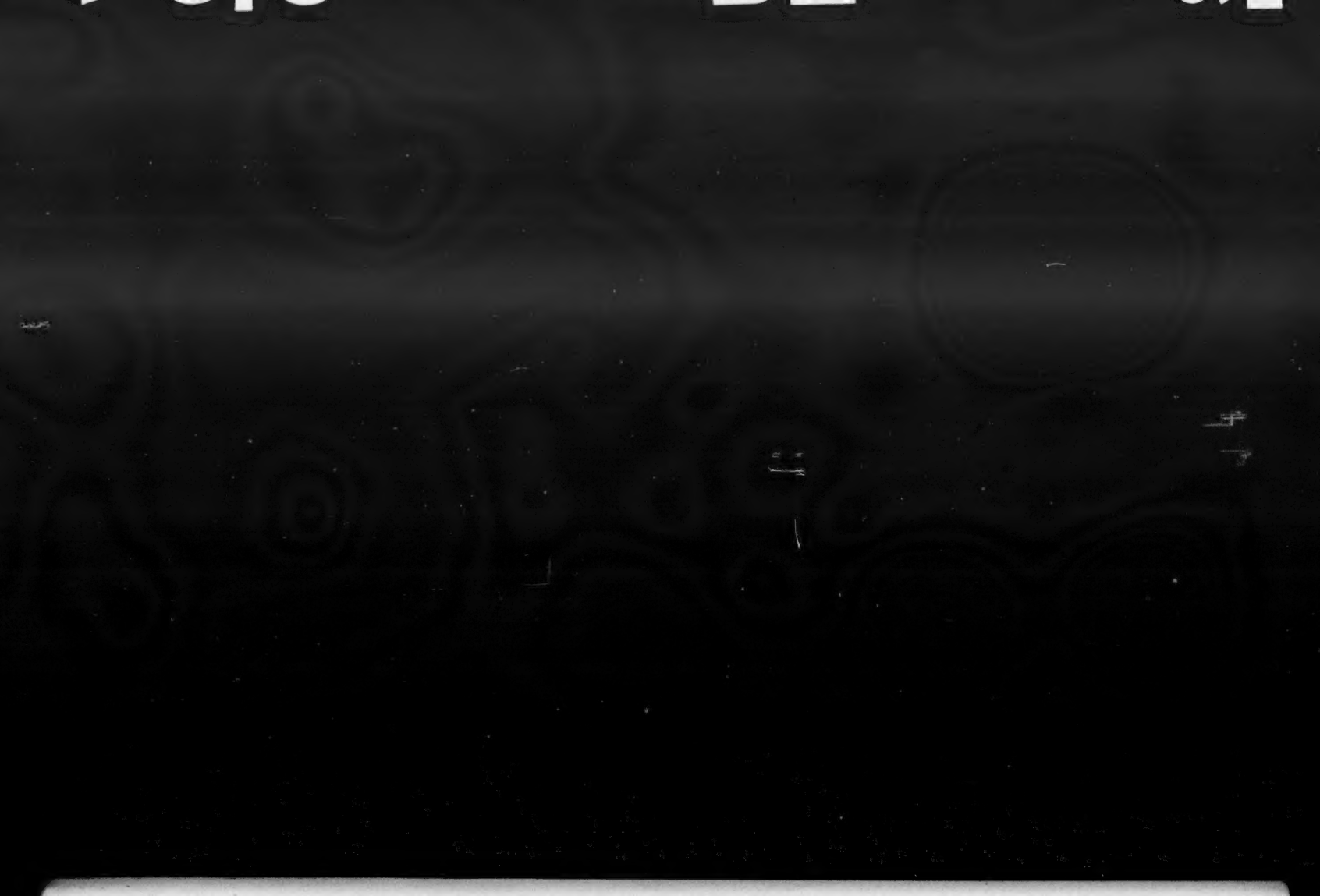
VIRGINIA STATE BOARD OF DENTAL EXAMINERS.

The next meeting of the Virginia State Board of Dental Examiners will be held in Richmond, Va., beginning at 9 o'clock on Tuesday morning, June 24th, 1919.

For further information and application blanks address:

J. LEWIS WALKER, Sec'y,
505 Taylor Bldg., Norfolk, Va.

RECENT PATENTS OF INTEREST TO DENTISTS.

1296473, Receptacle for blacking tooth-paste, and like plastic materials, Henry J. Brashier, London, England.
1296067, Tooth-brush, Alfred C. Fuller, Hartford, Conn.
1296186, Tooth-brush, Wm. J. Hines, New Britain, Conn.
1296429, Artificial tooth, Hugh W. Reynolds, Kendallville, Ind.
1296009, Artificial tooth attachment and making and utilizing the same, Joseph I. Richards, San Francisco, Cal.
1296231, Fastener for tooth-brush holders, Albert G. Tillman, Vicksburg, Miss.
1296140, Collapsible container, Edward O. Tinsley, Brooklyn, N. Y.
1296928, Artificial tooth, Arthur N. Cross, Philadelphia, Pa.
1296643, Dental surveying apparatus, Gilbert D. Fish, New York, N. Y.
1297199, Attaching means for removable dentures, Joseph A. McAuley, West New York, N. Y.
1296986, Single delivery tooth-pick holder, Walter G. McKay, Casper, Wyo.
1296846, Artificial tooth, Wm. R. Phelps, Milford, Del.
1296869, Blow torch, Leon C. Snow, Lincoln, Nebr.
1296884, Collapsible tube, Edward J. Volk, Cleveland, Ohio.
1297771, Rotary tooth-brush, Charles Abel, Fort Sam Houston, Texas.
1297448, Mold for making artificial teeth, Walter W. Crate, Camden, N. J.
1297561, Attaching means for dentures, Frank G. Guntner, White Plains, N. Y.
1297352, Dental tooth, Claude B. Hostetler, Ostrander, Ohio.
1297494, Dentifrice, Meyer L. Rhein, New York, N. Y.
1298041, Tooth-brush holder, James H. Harris, Ashland, Va.
1298419, Artificial tooth, Charles E. Summy, Pringhar, Iowa.

Copies of above patents may be obtained for fifteen cents each, by addressing John A. Saul, Solicitor of Patents, Fendall Building, Washington, D. C.